California Regional Water Quality Control Board
Santa Ana Region

November 30 2007

Item: **15**

Subject: **Consideration of Approval of the Plans and Schedules Submitted in Compliance with the Lake Elsinore and Canyon Lake Nutrient TMDLs Specified in the Water Quality Control Plan for the Santa Ana River Basin – Resolution No. R8-2007- 0083**

DISCUSSION

On December 20, 2004, the Regional Board adopted Resolution No. R8-2004-0037, amending the Water Quality Control Plan for the Santa Ana River Basin (Basin Plan) to incorporate Nutrient Total Maximum Daily Loads (TMDLs) for Lake Elsinore and Canyon Lake. The TMDLs were subsequently approved by the State Water Resources Control Board, the Office of Administrative Law (OAL) and the US Environmental Protection Agency (US EPA). The TMDLs, developed pursuant to Clean Water Act §303(d), address beneficial use impairment in Lake Elsinore and Canyon Lake due to excessive nutrients (phosphorus and nitrogen) discharged to the lakes from various sources in the watershed.

In summary, the Lake Elsinore and Canyon Lake Nutrient TMDLs include the following components: interim and final numeric targets for dissolved oxygen, chlorophyll a, ammonia, nitrogen and phosphorus; nitrogen and phosphorus wasteload allocations (WLAs) for point source discharges and load allocations (LAs) for nonpoint source discharges; and, an implementation plan and schedule to achieve reductions in nutrient loads. Compliance with the numeric targets, TMDLs, WLAs and LAs are to be achieved no later than December 31, 2020.

In order to achieve compliance with the numeric targets, TMDLs, WLAs and LAs, the Lake Elsinore and Canyon Lake Nutrient TMDLs require point source and nonpoint source dischargers to submit plans and schedules to reduce nutrient loads to Lake Elsinore and Canyon Lake, to conduct monitoring and to develop assessment tools for evaluating the Lakes' conditions. In order to implement the Nutrient TMDL requirements and to develop effective solutions for improving water quality in Lake Elsinore and Canyon Lake, affected responsible agencies and stakeholders have formed a Lake Elsinore and Canyon Lake TMDL Task Force. The Task Force is coordinating efforts to conduct watershed monitoring and to develop the proposed plans and schedules to meet TMDL requirements. Table 1 shows all the TMDL required tasks, due dates and the status of each task as of November 2007.

Table 1. Lake Elsinore and Canyon Lake Nutrient TMDL Implementation Plan/Schedule Report Due Dates and Status as of November 2007

Task	Description	Compliance Date-As soon As Possible but No Later Than	Status
Task 1	Establish New Waste Discharge Requirements	**March 31, 2006**	On-going
Task 2	Revise Existing Waste Discharge Permits	**March 31, 2006**	Complete/ On-going as needed
Task 3	Identify Agricultural Operators	**October 31, 2005**	Complete
Task 4	Nutrient Water Quality Monitoring Program 4.1 Watershed-wide Nutrient Monitoring Plan(s) 4.2 Lake Elsinore Nutrient Monitoring Plan(s) 4.3 Canyon Lake Nutrient Monitoring Plan(s)	• Initial plan/schedule due **December 31, 2005** • Annual reports due August 15 • Revised plan/schedule due **December 31, 2006**	2007 Annual report submitted *Complete and approved by Regional Board March 2006*
Task 5	Agricultural Discharges – Nutrient Management Plan	Plan/schedule due **September 30, 2007**	Draft submitted
Task 6	On-site Disposal Systems (Septic Systems) Management Plan	Dependent on State Board approval of relevant regulations	On-going
Task 7	Urban Discharges	Plan/schedule due:	
	7.1 Revision of Drainage Area Management Plan (DAMP)	7.1 **August 1, 2006**	Complete Revision will be incorporated during permit renewal
	7.2 Revision of the Water Quality Management Plan (WQMP)	7.2 **August 1, 2006**	Complete Revision will be incorporated during permit renewal
	7.3 Update of the Caltrans Stormwater Management Plan and Regional Plan	7.3 **April 1, 2006**	On-going
	7.4 Update of US Air Force, March Air Reserve Base SWPPP	7.4 Dependent on Task 4 results..	Evaluation underway
Task 8	Forest Area – Review/Revision of Forest Service Management Plans	Plan/schedule due **September 30, 2007**	Draft submitted
Task 9	Lake Elsinore In-Lake Sediment Nutrient Reduction Plan	Plan/schedule due **March 31, 2007**	Draft submitted
Task 10	Canyon Lake In-Lake Sediment Treatment Evaluation	Plan/schedule due **March 31, 2007**	Draft submitted Additional modeling on-going
Task 11	Watershed and Canyon Lake and Lake Elsinore In-Lake Model Updates	Plan/schedule due **March 31, 2007**	Draft submitted

Task	Description	Compliance Date-As soon As Possible but No Later Than	Status
Task 12	Pollutant Trading Plan	Plan/schedule due **September 30, 2007**	Draft submitted
Task 13	Review and Revise Nutrient Water Quality Objectives	December 31, 2009	N/A
Task 14	Review of TMDL/WLA/LA	Once every 3 years to coincide with the Regional Board's triennial review	The next triennial review is scheduled for 2009

Pursuant to the schedules specified in the Lake Elsinore and Canyon Lake Nutrient TMDLs, responsible dischargers have submitted the following for Regional Board consideration:

Task 5 – Agricultural Nutrient Management Plan[1]
Task 8 – Forest Area – Identification of Land Management Practices[2]
Task 9 – Lake Elsinore In-Lake Sediment Nutrient Reduction Plan[3]
Task 10 – Canyon Lake In-Lake Treatment Evaluation[3]
Task 11 – Watershed and Canyon Lake and Lake Elsinore In-Lake Model Updates[3]
Task 12 – Pollutant Trading Plan[3]

These submittals are summarized below.

Task 5: Agricultural Nutrient Management Plan

The TMDLs require agricultural operators to develop a proposed plan and schedule for the development and implementation of a Nutrient Management Plan.

In compliance with the TMDL requirements, in a September 12, 2007 letter, the Western Riverside County Agriculture Coalition (WRCAC) submitted for Regional Board review and approval a proposed plan and schedule for development and submittal of the Agricultural Nutrient Management Plan. The proposed plan relies on the coordination of on-going projects of the San Jacinto Basin Resource Conservation District (SJBRCD), the University of California Riverside (UCR), the United States Department of Agriculture Salinity Laboratory (USDA), the San Jacinto River Watershed Council (SJRWC), Scott Brothers Dairy Farms and the Lake

[1] Submitted by the Western Riverside County Agricultural Coalition on behalf of agricultural operators, including confined animal feeding operators.
[2] Submitted by the US Forest Service
[3] Submitted by the TMDL Task Force which consists of the following agencies/parties: the US Forest Service, the US Air Force (March Air Reserve Base), March Joint Powers Authority, California Dept. of Transportation (Caltrans), California Dept. of Fish and Game, the County of Riverside, the Riverside County Flood Control and Water Conservation District, Eastern Municipal Water District, Elsinore Valley Municipal Water District, and Western Riverside County Agricultural Coalition, and the cities of Lake Elsinore, Canyon Lake, Hemet, San Jacinto, Perris, Moreno Valley, Murrieta, Riverside and Beaumont. The Regional Board is a signatory to the Task Force agreement and is an advisory member of the Task Force.

Elsinore & Canyon Lake TMDL Task Force (Task Force). WRCAC proposes to consolidate the results of these projects into a proposed Nutrient Management Plan for submittal to the Regional Board by June 2010.

The proposed plan and schedule submitted by WRCAC is attached to tentative Resolution No. R8-2007-0083 (Attachment A). Staff have reviewed the proposal and finds that the proposed plan and schedule to develop the Agricultural Nutrient Management Plan satisfy the Lake Elsinore and Canyon Lake Nutrient TMDLs requirements.

Task 8: Forest Area – Identification of Forest Lands Management Practices

The TMDLs require the US Forest Service to evaluate nutrient discharges from forest activities in the San Bernardino National Forest and the Cleveland National Forest and to submit a plan and schedule to identify appropriate management measures for reducing nutrient discharges.

On September 27, 2007, Board staff received a draft submittal from the San Bernardino National Forest staff in compliance with the TMDL requirement (the San Bernardino National Forest Submittal covered the Cleveland National Forest as well). The submittal indicates that the existing Forest Plans are sufficient to meet the TMDL requirements; therefore, no amendments to the Forest Plans are needed. Board staff have requested additional information about BMP effectiveness monitoring in order to ensure that the management measures outlined in the Forest Plan will achieve the required nutrient load reduction. Forest Service staff have submitted additional information, including a list of BMP evaluation/monitoring reports and due dates that allow tracking of the effectiveness of BMPs.

The final proposed plan and schedule submitted by the US Forest Service is attached to tentative Resolution No. R8-2007-0083 (Attachment B). Staff have reviewed the proposal and finds that the proposed plan and schedule for BMP implementation satisfy the Lake Elsinore and Canyon Lake Nutrient TMDLs requirements.

Task 9: Lake Elsinore Sediment Nutrient Reduction Plan

Nutrient rich lake bottom sediment is a significant sink and source of nutrients to Lake Elsinore. Reduction and/or control of the flux of nutrients from the lake is necessary to ensure that the numeric targets are achieved. Since nutrients in Lake Elsinore bottom sediment originate from discharges from all nutrient sources in the watershed, all watershed stakeholders are responsible for the reduction of the in-lake nutrient sediment load. The TMDLs require stakeholders to submit a plan and schedule for the control of the in-lake nutrient sediment load.

By letter dated November 1, 2007, the Lake Elsinore/Canyon Lake TMDL Task Force, on behalf of all the responsible dischargers, submitted a final In-Lake Sediment Nutrient Reduction Plan (Plan). The plan relies on existing projects that have been or are being implemented to improve the water quality of Lake Elsinore, including lake level stabilization with recycled water, in-lake aeration and fishery management. Should any of these projects fail to achieve the numeric targets, ten additional control strategies that could be implemented are proposed. The Plan also includes compliance monitoring (both water quality and biological), and a project implementation schedule.

The final proposed plan and schedule submitted by the TMDL Task Force is attached to tentative Resolution No. R8-2007-0083 (Attachment C). Staff have reviewed the proposal and finds that the proposed plan satisfies the requirements of the Nutrient TMDLs.

Task 10: Canyon Lake Sediment Nutrient Treatment Evaluation Plan

As with Lake Elsinore, nutrients bound in Canyon Lake bottom sediment are also a significant nutrient source to Canyon Lake. To address this nutrient source, the TMDLs require the evaluation of potential sediment nutrient reduction treatment options.

On June 25, 2007, on behalf of all of the named dischargers, the San Jacinto River Watershed Council submitted a proposed Canyon Lake in-lake nutrient sediment evaluation plan. The report evaluated three in-lake treatment alternatives: alum treatment; aeration; and hypolimnetic oxygenation. Regional Board staff requested additional analysis to demonstrate that these alternatives will ensure compliance with the TMDL targets and allocations. To address Board staff's concern, the TMDL Task Force is proposing additional model analysis to assess the effectiveness of these three alternatives and their ability to ensure compliance with the TMDL targets. The model analysis is expected to be complete by the end of December 2007. A schedule for implementation of the preferred treatment alternative would be included as part of the modeling analysis.

Regional Board staff believes that the proposed evaluation plan and recommendations and the follow-up modeling analysis with an implementation schedule satisfies the requirement to develop a Canyon Lake Sediment Nutrient Treatment Evaluation Plan (Attachment D).

Task 11: Update of Watershed and In-Lake Nutrient Models

Given the large watershed, the variety of nutrient sources and the complex nature of nutrient dynamics in Lake Elsinore and Canyon Lake, model analysis was utilized to develop the Lake Elsinore and Canyon Lake nutrients TMDLs, WLAs and LAs. Any adjustments or refinements to the TMDLs, WLAs or LAs would also be based on model analysis. Therefore, the TMDLs require stakeholders to submit a plan and schedule for the update of the watershed water quality simulation models and both the Canyon Lake and Lake Elsinore in-lake nutrient models.

By letter dated November 1, 2007, the Lake Elsinore/Canyon Lake TMDL Task Force, on behalf of all dischargers in the watershed, submitted the final proposed schedule to update the existing nutrient watershed and in-lake water quality models. The plan proposes additional time before actual update of the model is initiated in order to allow sufficient time for data collection. This approach is appropriate considering that many projects are being implemented or planned for implementation in Lake Elsinore and Canyon Lake, as well as in the San Jacinto River watershed. Allowing additional time for monitoring will ensure that the model is representative of the changes that have occurred on the two lakes and in the watershed.

The final proposed plan and schedule for update of the watershed and in-lake models submitted by the TMDL Task Force is attached to tentative Resolution No. R8-2007-0083 (Attachment E). Staff has reviewed the proposal and finds that the proposed plan satisfies the requirements of the Nutrient TMDLs.

Task 12: Pollutant Trading Plan

During development and Regional Board consideration of the Lake Elsinore and Canyon Lake Nutrient TMDLs, many stakeholders recommended that the TMDLs provide the opportunity for pollutant trading, with the goal of ensuring that the expenditure of limited funding would be targeted to where it would be the most beneficial. A specific task for the stakeholders to develop a pollutant trading plan was incorporated into the TMDLs.

By letter dated November 1, 2007, the Lake Elsinore/Canyon Lake TMDL Task Force, on behalf of all dischargers in the watershed, submitted a plan and schedule that outlines the steps to develop a pollutant trading plan. Because additional nutrient source data, in conjunction with accurate model analysis, are needed to identify trading options, the Task Force proposes to develop the pollutant trading plan after the model update is complete. Board staff agrees that this approach is appropriate.

The final proposed plan and schedule for development of the Pollutant Trading Plan submitted by the TMDL Task Force is attached to tentative Resolution No. R8-2007-0083 (Attachment F). Staff has reviewed the proposal and finds that the proposed plan satisfies the requirements of the Nutrient TMDLs.

STAFF RECOMMENDATION

Adopt Resolution No. R8-2007-0083, approving the attached plans and schedules as submitted by the Lake Canyon/Lake Elsinore Nutrient TMDL Task Force and individual groups of dischargers as shown in attachments to the Resolution:

1. Agricultural Nutrient Management Plan (Attachment A to Resolution No. R8-2007-0083)
2. Forest Service Land Practices Identification Plan (Attachment B to Resolution No. R8-2007-0083)
3. Lake Elsinore Sediment Nutrient Reduction Plan (Attachment C to Resolution No. R8-2007-0083)
4. Canyon Lake Sediment Nutrient Treatment Evaluation Plan and Model Analysis Plan (Attachment D to Resolution No. R8-2007-0083)
5. Update of Watershed and In-Lake Nutrient Models (Attachment E to Resolution No. R8-2007-0083)
6. Pollutant Trading Plan (Attachment F to Resolution No. R8-2007-0083)

California Regional Water Quality Control Board
Santa Ana Region

RESOLUTION NO. R8-2007-0083

Resolution Approving Plans and Schedules Submitted by the Canyon Lake/Lake Elsinore TMDL Task Force and Individual Discharger Groups Pursuant to the Lake Elsinore and Canyon Lake Nutrient Total Maximum Daily Loads Specified in the Water Quality Control Plan for the Santa Ana River Basin

WHEREAS, the California Regional Water Quality Control Board, Santa Ana Region (hereinafter Regional Board), finds that:

1. An updated Water Quality Control Plan for the Santa Ana River Basin (Basin Plan) was adopted by the Regional Board on March 11, 1994, approved by the State Water Resources Control Board (SWRCB) on July 21, 1994, and approved by the Office of Administrative Law (OAL) on January 24, 1995.

2. Amendments to the Basin Plan to incorporate Lake Elsinore and Canyon Lake Nutrient Total Maximum Daily Loads (TMDLs) were approved by the Regional Board on December 20, 2004, by the State Water Resources Control Board on May 19, 2005, by the Office of Administrative Law on July 26, 2005 and by the US Environmental Protection Agency on September 30, 2005.

3. The Lake Elsinore and Canyon Lake Nutrient TMDLs were developed in accordance with Clean Water Act Section 303(d) and the California Water Code, Division 7, Chapter 4, Article 3, Section 13240 *et seq*. The amendment is incorporated into Chapter 5 "Implementation", of the Basin Plan.

4. Responsible agencies and dischargers in the Lake Elsinore/Canyon Lake watershed have formed a Lake Elsinore and Canyon Lake TMDL Task Force (TMDL Task Force). The TMDL Task Force members are working jointly to implement requirements of the Lake Elsinore and Canyon Lake Nutrient TMDLs. TMDL Task Force members include the following agencies/parties: the US Forest Service, the US Air Force (March Air Reserve Base), March Joint Powers Authority, California Dept. of Transportation (Caltrans), California Dept. of Fish and Game, the County of Riverside, the Riverside County Flood Control and Water Conservation District, Eastern Municipal Water District, Elsinore Valley Municipal Water District, Western Riverside County Agricultural Coalition, and the cities of Lake Elsinore, Canyon Lake, Hemet, San Jacinto, Perris, Moreno Valley, Murrieta, Riverside and Beaumont.

5. The Regional Board is a signatory to the Task Force Agreement and serves as an advisory member of the TMDL Task Force.

6. The Lake Elsinore and Canyon Lake Nutrient TMDLs, Task 5 - Agricultural Activities requires the agricultural operators within the Lake Elsinore and Canyon Lake watershed to submit a proposed Nutrient Management Plan (NMP) by September 30, 2007.

7. In compliance with the Task 5 – Agricultural Activities, by letter dated September 12, 2007 and on behalf of agricultural operations in the San Jacinto River watershed, including confined animal feeding operators, the Western Riverside County Agricultural Coalition (WRCAC), submitted for Regional Board review and approval a proposed plan and schedule for development of the Agricultural Nutrient Management Plan.

8. The Regional Board has reviewed the proposed plan and schedule for development of the Agricultural Nutrient Management Plan and finds that it complies with the applicable requirements of the Lake Elsinore and Canyon Lake Nutrient TMDLs specified in the Basin Plan.

9. The Lake Elsinore and Canyon Lake Nutrient TMDLs, Task 8 - Forest Area – Identification of Forest Lands Management Practices requires the US Forest Service to submit by September 20, 2007 for Regional Board review and approval, a plan with a schedule for identification, development and implementation of Management Practices to reduce nutrient discharges emanating from the Cleveland National Forest and the San Bernardino National Forest.

10. In compliance with Task 8 - Forest Area – Identification of Forest Lands Management, by letter dated September 27, 2007, the San Bernardino National Forest staff submitted a proposed list of the existing Forest Plans that are pertinent to achieve compliance with the TMDL requirements, and a list of BMP evaluation/monitoring reports. The submittal addresses Forest Plans for both the San Bernardino and Cleveland National Forests. Additional information submitted by the Forest Service on October 25, 2007, includes requested information on BMP effectiveness monitoring.

11. The Regional Board has reviewed the Forest Service existing projects and supplemental information provided and finds that the Forest Service submittal complies with the applicable requirements of the Lake Elsinore and Canyon Lake Nutrient TMDLs specified in the Basin Plan.

12. The Lake Elsinore and Canyon Lake Nutrient TMDLs, Task 9 - Lake Elsinore Sediment Nutrient Reduction Plan requires all dischargers to submit by March 31, 2007 for Regional Board review and approval a proposed plan and schedule for reduction of in-lake sediment nutrient loads for Lake Elsinore.

13. In compliance with Task 9 - Lake Elsinore Sediment Nutrient Reduction Plan, by letter dated November 1, 2007, the Lake Elsinore/Canyon Lake TMDL Task Force, submitted for Regional Board review and approval a final In-Lake Sediment Nutrient Reduction Plan. The Plan includes existing projects and new strategies to improve water quality in Lake Elsinore, compliance monitoring (both water quality and biological), and an implementation schedule.

14. The Regional Board has reviewed the proposed Lake Elsinore in-lake nutrient reduction plan and schedule and finds that it complies with the applicable requirements of the Lake Elsinore and Canyon Lake Nutrient TMDLs specified in the Basin Plan.

15. The Lake Elsinore and Canyon Lake Nutrient TMDLs, Task 10 - Canyon Lake Sediment Nutrient Treatment Evaluation Plan requires specified nutrient dischargers to submit by

March 31, 2007 for Regional Board review and approval a proposed plan and schedule for evaluating in-lake sediment nutrient treatment strategies for Canyon Lake.

16. In compliance with Task 10 – Canyon Lake Sediment Nutrient Treatment Evaluation Plan, by letter dated June 25, 2007, the San Jacinto River Watershed Council submitted for Regional Board review and approval a proposed Canyon Lake in-lake nutrient sediment evaluation plan. Additional model analysis is being conducted by the TMDL Task Force to ensure that the proposed nutrient sediment reduction alternatives would achieve compliance with the TMDL targets and to develop an implementation schedule. The model analysis is expected to be completed by December 2007.

17. The Regional Board has reviewed the proposed Canyon Lake in-lake nutrient treatment evaluation plan and the proposed plan to conduct additional model analysis and develop an implementation schedule. The proposed plans will comply with the applicable requirements of the Lake Elsinore and Canyon Lake Nutrient TMDLs specified in the Basin Plan.

18. The Lake Elsinore and Canyon Lake Nutrient TMDLs, Task 11- Update of Watershed and In-Lake Nutrient Models requires all nutrient dischargers to submit by March 31, 2007 for Regional Board review and approval a proposed plan and schedule for updating the existing Lake Elsinore/San Jacinto River Nutrient Watershed Model and the Canyon Lake and Lake Elsinore in-lake models.

19. In compliance with Task 11 – Update of Watershed and In-Lake Nutrient Models, by letter dated November 1, 2007, the TMDL Task Force submitted for Regional Board review and approval a proposed plan and schedule for update of the watershed and in-lake water quality models.

20. The Regional Board has reviewed the proposed plan and schedule for Update of Watershed and In-Lake Nutrient Models and finds that it complies with the applicable requirements the Lake Elsinore and Canyon Lake Nutrient TMDLs specified in the Basin Plan.

21. The Lake Elsinore and Canyon Lake Nutrient TMDLs, Task 12 - Pollutant Trading Plan requires specified dischargers to submit by September 30, 2007 for Regional Board review and approval a proposed Pollutant Trading Plan.

22. In compliance with Task 12 – Pollutant Trading Plan, by letter dated November 1, 2007, the TMDL Task Force submitted for Regional Board review and approval a proposed plan and schedule for development of a pollutant trading plan.

23. The Regional Board has reviewed the proposed Pollutant Trading Plan and schedule and finds that it complies with the applicable requirements of the Lake Elsinore and Canyon Lake Nutrient TMDLs specified in the Basin Plan

NOW, THEREFORE, BE IT RESOLVED THAT:

1. The Regional Board approves the following plans and schedules as set forth in the attachments:

Attachment A – Agricultural Nutrient Management Plan
Attachment B – Forest Service Land Practices Identification
Attachment C – Lake Elsinore Sediment Nutrient Reduction Plan
Attachment D – Canyon Lake Sediment Nutrient Treatment Evaluation Plan
Attachment E – Watershed and In-Lake Nutrient Models Update Plan
Attachment F – Pollutant Trading Plan

2. These plans comply with the respective requirements of the Lake Elsinore and Canyon Lake Nutrient TMDLs specified in the Basin Plan.

3. Agricultural operators, the US Forest Service and members of the TMDL Task Force are in compliance with the Lake Elsinore and Canyon Lake Nutrient TMDLs.

4. These plans and schedules must be implemented upon Regional Board approval.

I, Gerard J. Thibeault, Executive Officer, do hereby certify that the foregoing is a full, true and correct copy of a resolution adopted by the California Regional Water Quality Control Board, Santa Ana Region, on November 30, 2007.

Gerard J. Thibeault
Executive Officer

Attachment A.

Agricultural Nutrient Management Plan

September 12, 2007

Santa Ana Regional Water Quality Control Board
Attention: Mr. Jerry Thibeault
3737 Main Street, Suite 500
Riverside, CA 92501

Re: Agricultural Nutrient Management Plan (Ag NMP)
TMDL Compliance Issue

The Basin Plan Amendment requires, no later than September 30, 2007, that agricultural operators within the Lake Elsinore and Canyon Lake watershed submit a proposed plan and schedule for development of the Agricultural Nutrient Management Plan (Ag NMP).

The Western Riverside County Agriculture Coalition (WRCAC), a non-profit organization, in conjunction with the San Jacinto Basin Resource Conservation District (SJBRCD), the University of California Riverside (UCR), the United States Department of Agriculture Salinity Laboratory (USDA), the San Jacinto River Watershed Council (SJRWC), Scott Brothers Dairy Farms and the Lake Elsinore & Canyon Lake TMDL Task Force (Task Force) have been working diligently over the past few years on the development of a strategy to address agricultural issues in the San Jacinto Watershed.

We believe that as a group of interested agricultural parties, we have met the Agricultural NMP TMDL compliance requirement due to the RWQCB by September 30, 2007. There are several documents that have either been completed or are in progress to achieve our goal and identify BMPs for dairy and agriculture, including reduction strategies, and implementation of nutrient controls. Additionally, the dairy and agricultural stakeholders are active participants in the TMDL Task Force and therefore part of the Watershed monitoring activities that have been implemented. Documents included for your consideration are:

- An Integrated, Regional Dairy Management Plan with BMP Implementation in the San Jacinto Watershed (SJBRCD)
- TMDL Agricultural Operator Voluntary Plan for the San Jacinto Watershed (WRCAC)
- Assessment of Best Management Practices to Reduce Nutrient Loads in the San Jacinto River Watershed (UCR)
- Transport and Fate of Nitrate and Pathogens at a Dairy Lagoon Water Application Site: An Assessment of CNMP Performance (USDA/EPA grant through USDA Salinity lab)
- San Jacinto Watershed Monitoring (TMDL Task Force)
- Analysis and Development of a Manure Manifesting System (SAWA/WRCAC)
- (SEP) Source Identification for Phosphorous, Nitrates and Salts in the San Jacinto Watershed and Identification of Technologies and Alternate Control Measures Report

Completion of the projects listed above will provide additional recommendations for nutrient reductions in the watershed and ultimately additional BMPs for implementation. Ultimately, the Agricultural community will have a consolidated effort in place that addresses both dairy and agricultural environmental concerns for the future.

Western Riverside County Agriculture Coalition
P.O. Box 892
Nuevo, CA 92567

Below is a brief summary of each of the projects:

An Integrated, Regional Dairy Management Plan with BMP Implementation (SJBRCD)

This Integrated, Regional Dairy Management Plan (IRDMP) project addresses two (2) of the Santa Ana RWQCB's priority projects for the 2005/2006 Consolidated Grants Program. The two (2) Priority Watershed Management Area (WMA) targeted projects are:

- Measurable reductions in the loads of nutrients (nitrogen and phosphorous) and pathogens reaching Canyon Lake and Lake Elsinore through regional and individual BMPs.
- Projects that improve the quality of groundwater that have been degraded by historic agricultural and dairy practices.

In summary, this submittal provides:

1. An Integrated Regional Dairy Management Plan, a comprehensive, regional and holistic approach, which addresses specific BMP's and actions that can be taken to achieve reduced pollutant loads and restore the impaired beneficial uses of Canyon Lake and Lake Elsinore;
2. A TMDL monitoring program specific to the upper San Jacinto Watershed that addresses Dairy/CAFO data collection and pertinent surrounding areas i.e., Mystic Lake area.
3. Two worthy pilot demonstration projects: Spatio-Temporal Assessment of Nutrient Management Performance and CAFO Wastewater Treatment System Using Vibratory Shear Enhancement Processing (VSEP) which will address reduction strategies to meet load allocations and evaluate the effectiveness of these BMPs.

TMDL Voluntary Ag Operator Plan for the San Jacinto Watershed (WRCAC)

This project develops an implementation process that allows agricultural stakeholders, dairy and agriculture, a voice in the voluntary process and an active role in stakeholder allocation commitment. It also improves the ag database, GIS mapping tools and on-going education for agriculture on the TMDL. Identification of agricultural runoff discharges in the watershed during large storm events for agricultural parcels is another key component.

Assessment of Best Management Practices to Reduce Nutrient Loads in the San Jacinto River Watershed (UCR)

This grant evaluates various BMPs for reducing pollutant loads from ag fields and different types of crops grown in the watershed and estimates pollutant loads under different scenarios. Unfortunately, this grant was a year and a half late being executed and they have obtained little data due to a very dry year.

Transport and Fate of Nitrate and Pathogens at a Dairy Lagoon Water Application Site: An Assessment of CNMP Performance (USDA Salinity lab)

The initial pilot demonstration site was set up on a small parcel (less than an acre) through an EPA/USDA grant awarded to the UCR USDA Salinity Lab. The larger field scale demonstration (70 acres) BMP is described in detail in the Integrated, Regional Dairy Management Plan grant. This project assesses implementation of nutrient controls, BMP's and reduction strategies.

San Jacinto Watershed Monitoring (TMDL Task Force)

WRCAC is the single voice representing agriculture and dairy on the Lake Elsinore and Canyon Lake TMDL Task Force. They are active members of the TMDL Task Force and as such participate in the current activities of the Task Force including ongoing watershed compliance monitoring. Over the past two years, Canyon Lake Monitoring was completed through a grant awarded to the SJRWC and all stakeholders benefited. The Annual report was just filed.

Analysis and Development of a Manure Manifesting System

The Western Riverside County Agriculture Coalition (WRCAC) has identified this Best Management Practice (BMP) concept as a worthy alternative to investigate reducing nutrients and salts in the watershed. We believe a thorough analysis of issues and design of a refined manure manifesting system would assist the CAFO's and Agriculture operators to meet TMDL nutrient reduction targets over the next several years.

(SEP) Source Identification for Phosphorous, Nitrates and Salts in the San Jacinto Watershed and Identification of Technologies and Alternate Control Measures Report

In May of 2006, the Western Riverside County Agriculture Coalition completed a SEP project, funded by the Santa Ana RWQCB, identifying baseline survey data on all dairies in the watershed and potential BMP's that could be implemented. This is the baseline information being used as the foundation for the dairy management grant.

The proposed Implementation schedule is as follows:

	IMPLEMENTATION ACTION	ESTIMATED COMPLETION DATE
1	Ag NMP submitted to RWQCB	9/12/07
2	Watershed monitoring	Ongoing (TMDL Task Force)
3	TMDL Grant • Ag BMPs Technical memo	3/31/08
4	UCR Grant • Ag BMP recommendations	6/31/08
5	TMDL Grant Final Report	12/31/08
6	Integrated, Regional Dairy Management • Plan for the San Jacinto with BMP implementation	12/31/09
7	Participation in the development of the pollutant trading model through the TMDL Task Force	As indicated by Task Force
8	Manure Manifest Project • Technical memo with manure reduction strategies to be incorporated into IRDMP	6/30/08
	*SEP and USDA pilot project have been completed	
9	FINAL Ag NMP	6/30/10

The Final Ag NMP report will consolidate all of the BMPs and recommendations and will be submitted to the RWQCB by no later than 6/30/10.

WRCAC is proud of the work that they have accomplished and believe that the cumulative result of these projects exceeds the San Jacinto Ag Nutrient Management Plan requirement. Copies of the various grant scope of work or final reports are attached in CD format.

The agricultural community has taken a very proactive approach to addressing water quality issues in the San Jacinto Watershed as evidenced by the significant amount of work and grants in progress. The dairy and ag operators in the San Jacinto Watershed had the foresight to invest their time to develop a strategy that will benefit all of the stakeholders in the watershed and sustain the agricultural community for the future. Should you have any additional questions, please feel free to contact me at (951) 808-8531 or via email at mpboldt@aol.com.

Sincerely,

Pat Boldt

Pat Boldt
WRCAC Executive Director
September 12, 2007

CC: Hope Smythe, RWQCB
Gayle Holyoak, SJBRCD
Bruce Scott, WRCAC
Scott Bradford, USDA UCR Salinity lab
Mark Norton, TMDL Task Force Administrator

Attachments:
-SOW for Grant Agreement No. 06-279-558-0 (SJBRCD)
-Executed Grant Agreement No. 06-280-558-0 (WRCAC)
-Executed Grant Agreement No. 05-040-558-0 (UCR)
-Manure Manifest SOW
-LESJWA Annual Monitoring Report (August, 2007)
-USDA Quarterly Reports (USDA, 2005-2007)
-Supplemental Environmental Project (May, 2006)

Attachment B.

Forest Service Land Practices Identification Plan

Forest Nutrient Management Plan
Schedule of Reports

Type of Report	Information provided	Expected annual date
Schedule of Proposed Actions (SOPA)	http://www.fs.fed.us/r5/sanbernardino/projects/index.shtml Status (NEPA planning, scoping, decisions, implementation) of all ongoing projects across the Forest	Updated quarterly
BMPEP monitoring	Implementation and Evaluation of BMPs at randomly selected projects across the Forest	January
LMP monitoring	Land Management Plan requires 10% of projects to be monitored to determine if NEPA decision was appropriately followed	January
Project specific implementation monitoring	BMPs will be monitored during implementation at projects where activities could impact roads crossings, stream buffers, etc (e.g. fuels treatments, roads, recreation) in major drainages of the San Jacinto River	January 2009 first report
Water quality monitoring	Up to 9 locations are to be monitored for phosphorous constituents every two months depending on rainfall and funding.	June 2008 for first report
Fire suppression rehabilitation plans	After the fire suppression has occurred, a plan is used to guide the rehabilitation of handlines and dozer lines	As applicable
Burned Area Emergency Response (BAER)	The summary report is the 2500-8. Accompanying this are specialist reports from hydrology/soils, biology, archaeology. The 2500-8 and specialist reports are made available to multiple agencies.	As applicable

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File Code: 2520/2520-5
Date: September 26, 2007

Hope Smythe
Chief of Basin Planning, Inland Waters
Santa Ana Regional Water Quality Control Board
3737 Main Street, Suite 500
Riverside, CA 92501

HAS

SEP 27 2007

In accordance with the Lake Elsinore/Canyon Lake Nutrient TMDL Implementation Plan, the following documentation is submitted to fulfill Task 8 - Forest Nutrient Management Plan for San Bernardino National Forest (BDF) and Cleveland National Forest (CNF) system lands. We would appreciate review and comment as we continue to work together to our mutual benefit and protection of water quality.

During the recent update of the Southern California Forests Land Management Plans (LMP). TMDL compliance through use of best management practices was specifically called out under Design Criteria WAT 2 - Water Management, which states, in part:

- Take appropriate actions to meet Total Maximum Daily Load (TMDL) standards.
- Protect and improve water quality by implementing best management practices and other project-specific water quality protection measures for all national forest and authorized activities.

In addition, the Forests updated the Soil and Water Conservation Practices Handbook to stress the importance of using BMPs on all projects and focusing specific protection measures in Riparian Conservation Areas (RCAs) which buffer all perennial and intermittent water courses.

After a thorough review of the Forest Plans (excerpts included) and consultation with Forest Planners on the BDF and CNF, it was determined that a Forest Plan Amendment is not necessary.

BMPs regularly undergo monitoring during the implementation stage of projects. Monitoring of the effectiveness of BMPs is conducted annually through the BMP evaluation protocol (BMPEP) process and the newer LMP monitoring requirements. Monitoring and evaluation of the LMP helps the Forests and the public to determine how the LMP is being implemented, whether implementation is achieving desired outcomes, and whether assumptions made in the planning process are valid. The monitoring reports for the BMPEP process and the LMP process will be available this fall.

Compliance monitoring at locations on the BDF and near Cranston station will continue, dependent on sufficient rainfall and funding.

Forest contacts for this topic are Robert G. Taylor (909-382-2660) [BDF] and Gloria Silva (858-524-0136) [CNF].

Sincerely,

/s/ Max Copenhagen
JEANNE WADE EVANS
Forest Supervisor

cc: Robert G Taylor
Gloria Silva
Barry Hill

Summary

The San Bernardino National Forest (BDF) and the Cleveland National Forest (CNF) recently (2005) completed a new Land Management Plan (Forest Plan) to cover all of our activities for the next 10 to 15 years. A number of excerpts are contained herein to clarify how watershed, riparian, and soil protections were studied and used to influence the decision.

The Lake Elsinore/Canyon Lake TMDL Basin Plan Amendment set forth a task for the USDA Forest Service.

> No later than (**2 years from effective date of this Basin Plan amendment **), the US Forest Service shall submit for approval a plan and schedule for review and revision of the Cleveland National Forest Service Management Plan and the San Bernardino National Forest Service Management Plan to identify watershed -specific appropriate Best Management Practices (BMPs) that will be implemented to achieve the interim and final load allocations for forest/open space. The proposal shall include specific recommendations for 1) evaluating the effectiveness of control actions implemented to reduce nutrient discharges from forest/open space and 2) evaluating compliance with the nutrient load allocation from forest/open space. The revised watershed-specific BMPs shall be implemented upon Regional Board approval at a duly noticed public meeting.

It is the opinion of the BDF and CNF that the Forest Plan does not need to go through the formal Plan Amendment Process to meet the needs of this implementation task.

As is detailed in the following, the Forests are required to analyze watershed, riparian habitat, and soils issues for all significant projects on the Forest. Specific to these areas, the following guidelines are consistently used in all environmental documents.

RCAs - Riparian Conservation Areas

Riparian Conservation Areas are managed to maintain or improve conditions for riparian-dependent natural resources. Activities should be (a) neutral, (b) move the area closer towards the riparian area desired condition, or (c) move towards the riparian management objectives defined in the forest plans. Watersheds are managed to maintain functioning riparian areas and improve or restore degraded riparian areas to proper functioning condition for native populations of riparian-dependent species.

The ***Five-Step Project Screening Process for Riparian Conservation Areas*** described below is used to assist in ensuring that riparian conservation areas (RCAs) are recognized, emphasized and managed appropriately during new project planning and implementation.

This screening process is used in addition to the land allocation restrictions that apply to the project area. For example, mechanized fuels treatments are allowed in riparian conservation areas (based on consistency with the riparian management objectives). However, where a riparian conservation area overlaps with a wilderness area, treatments are limited to non-mechanized and non-motorized methods.

Step 1: Determine riparian conservation area width by stream type based on the following criteria:

Stream Type	**Width Of The Riparian Conservation Area**
Perennial Streams	328 feet (100 meters) on each side of the stream, measured from the bank full edge of the stream
Seasonally Flowing/ Intermittent Streams	98 feet (30 meters) on each side of the stream, measured from the bank full edge of the stream
Streams in Inner Gorge (*)	Top of inner gorge
Special aquatic features (**) or perennial streams with riparian conditions extending more that 164 feet (50 meters) from edge of streambank, or seasonally flowing/intermittent streams with riparian conditions extending more that 33 feet (10 meters) from edge of streambank	328 feet (100 meters) from edge of feature or riparian vegetation, whichever width is greater
Other hydrological or topographic depressions without a defined channel (meadows, vernal pools, etc)	RCA width and protection measures determined through project level analysis

(*) Inner gorge is defined by adjacent stream slopes greater than 70 percent gradient
(**) Special Aquatic Features include: lakes, ponds, wetlands, seeps, and springs

Step 2: Use the environmental GIS layer and species accounts to determine additional protective RCA widths specific to individual species or suites of species (e.g., arroyo toad has a topographical contour distance from water, etc.).

Step 3: Screen new projects against the riparian and aquatic desired conditions (Part 1, Strategic Goals - Goal 5.2 - Riparian Condition and Goal 6.2 - Biological Resource Conditions), and recovery plans for federally listed riparian dependent species to determine if the proposal is either neutral or will move the area closer towards the desired conditions. If it does, then proceed to Step 4. If it does not, there is a need to modify the project proposal, deny the proposal or complete a project-driven land management plan amendment.

Step 4: Screen new projects against the forest plan riparian management objectives (Part 2, Appendix B Program Strategies and Tactics, WAT-1 and WAT-2) to ensure that the project incorporates one or more of the listed strategies. As part of the analysis consider physical factors, such as soil characteristics, groundwater and surface water characteristics, geology and geologic hazards, slope, and stream characteristics; and biological factors, such as aquatic and riparian dependent species present, their habitat needs (see species guidance documents in Part 3, Appendix H), and the ability of the existing environment to provide needed habitat.

Step 5: Refer to *Forest Service Handbook (FSH 2509.22) - Forest Supplement* for specific guidance about management tactics to apply when conducting activities within RCAs. ***Note:*** Modification of specific RCA widths for individual projects is possible if a need is identified during the interdisciplinary team (IDT) process; an earth scientist or biologist has participated in the proposed change; and it has become part of the proposed action for Line Officer approval. Use a peer review process for vegetation treatments or other activities proposed within an RCA that are likely to significantly affect riparian or aquatic resources.

Forest Service Handbook (FSH) 2509.22 —SOIL AND WATER CONSERVATION PRACTICES HANDBOOK

Section 3.22

The properties of the soils within the project area are analyzed as a part of the environmental review process to determine the erosion potential. Erosion is defined as the removal of soil by the action of water or wind. Erosion potential should be determined by a combination of the following: soil type, percent slope, percent ground cover, ground disturbance, distance from the stream, and amount and intensity of wind/rainfall. Soil stabilization is determined based on the above site factors.

The Erosion Hazard Rating (EHR) is used to guide land management activities on erosive lands. During project activities, minimize excessive loss of organic matter and limit soil disturbance according to the EHR as follows:

3.22 - Exhibit 01

Minimum Effective Ground Cover based on Erosion Hazard Rating.

EHR	Minimum Effective Ground Cover
Low (4-5)	40 percent
Moderate (6-8)	50 percent
High (9-10)	60 percent
Very High (11-13)	70 percent

EHR	Minimum Effective Ground Cover
4 to 8	Conduct normal activities
9 to 10	Minimize or modify use of soil-disturbing activities
11 to 13	Severely limit soil-disturbing activities

For vegetation manipulation projects, the EHR and minimum effective ground cover are further clarified with the following conditions:

1. Protective ground cover consists of any combination of living plants, litter, slash and duff.
2. Litter and slash should be 2 inches deep, and made up of material 4 inches or less in diameter to qualify as protective ground cover in mixed conifer forests. In other areas outside of mixed conifer forests determine amounts based on local conditions.
3. In forested types duff or humus should be an average of 1 inch deep to qualify as protective groundcover or within site potential. *Note*: this condition seldom exists in chaparral.
4. The USDA Region 5 Rangeland Analysis and Planning Guide (USDA Forest Service 1997) is one source to use for techniques to determine ground cover at the site-specific level.

Vegetation management (removal or alteration) within an RCA should not reduce riparian ground cover by more than 30 percent (maximum) of that which naturally occurs within the project area (does not apply to wildfires or other unplanned emergency actions). Vegetation treatments designed to rejuvenate or protect riparian vegetation, which would only temporarily alter vegetation, are not limited.

Where percent ground cover is less than prescribed, treatments should be applied that increase cover to minimum standards as natural conditions allow. Possible treatments include: establishment of living plants, introduction of litter, slash or other treatments as prescribed by an earth scientist or biologist.

Evaluating Effectiveness of Control Actions

Water quality management for National Forest System lands in California – best management practices (September 2000)

Pursuant to Section 208 of the Clean Water Act, all agencies responsible for carrying out any portion of a State Water Quality Management Plan must be designated as a Water Quality Management Agency (WQMA). Through the execution of a formal Management Agency Agreement (MAA) with the Forest Service in 1981, the SWRCQ designated the Forest Service (USFS) as the WQMA for NFS lands in California.

The following actions will be used to carry our water quality management:

1) Correct Water Quality Problems on the national Forests
    a. NFS lands exhibit conditions that are, or have the potential to be, a source of nonpoint pollution. These conditions exist as a result of past management actions by the Forest Service, or other landowners, and as the result of natural occurrences such as fires and floods.
    b. These existing and potential nonpoint sources will be evaluated to determine the need for and type of treatments necessary. Those lands found to be in need of watershed improvement work will be scheduled for treatment as part of the ongoing work planning and budgeting process.
    c. Accomplishment is dependent on funding and personnel availability, and work priority relative to other management goals and objectives.
2) Perpetually Implement Best Management Practices
    a. Involves training, keeping BMPs current, and BMP monitoring and evaluation
3) Carry Out Identified processes for improving, or developing best management practices

The Forest Supervisor shall:

1) Apply BMPs for water quality protection and improvement in day-to-day management activities
2) Evaluate attainment of water quality management goals through formal and informal reviews of project planning, and through monitoring using BMPEP protocols
3) Conduct BMP training annually on an as needed basis, before each field season for new employees, new line officers, and new resource personnel.

To evaluate the effectiveness of the BMPs that are detailed in the environmental documents and specified in the design criteria for contracts, implementation monitoring is done by the District and Forest staff involved in the projects in anticipation of post-winter effectiveness monitoring. The BDF is given an annual target of the number of projects needing to be monitored. The annual monitoring locations are determined using a random selection process for all projects on the Forest.

Based on the annual targets and the random selection protocols, this monitoring scheme coincides with checking approximately one fuels unit with landings, skid trails, and roads on the San Jacinto District; one road maintenance project on the San Jacinto District; and one recreation facility on the San Jacinto District on a yearly basis.

Evaluating Compliance with the Nutrient Load Allocation

The BDF and CNF have agreed to conduct compliance monitoring during storm situations near the Cranston Guard Station. During meetings in 2007 with the Riverside County Flood Control District, the BDF learned that for best modeling purposes flows at the USGS Cranston gage needed to be on the order of 300 cfs or above before flows from the base of the BDF Congressional boundary will reach significantly downstream.

Therefore, the BDF has set aside funds to monitor at the Cranston USGS gage during these large storm events, as detailed in the BDF LE/CL Nutrient TMDL Monitoring sampling and analysis plan (June 2006).

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Introduction

All of the actions that the Forest Service takes are in conformance with the recently updated Land Use Management Plan (Forest Plan). All projects suggested internally and by external partners must first show that they conform to the Forest Plan. The Final Environmental Impact Statement discussed all the direct, indirect, and cumulative effects of choosing the various alternatives analyzed. This multi-year effort led to the direction for the next 10-15 years. Watershed protection and enhancement were analyzed in the various alternatives. The Forest Service is a multi-use land management agency, allowing for multiple proponents to use the land. In addition, the Forest Service looked closely at the effects of increased population pressure, recreation uses. and private land contained within the boundaries of the Forest.

A number of documents are included by reference (e.g. The Forest Plan [ROD, FEIS, Parts 1, 2, & 3, 2005], supplements such as the Soil and Water Conservation Practices Handbook (2005), the SBNF Business Plan (2004), the Best Management Practices Handbook (2000), the current SBNF Schedule of Proposed Actions (SOPA, June 2007)). However, to show the Santa Ana Regional Water Quality Control Board (RWQCB) that watershed (and implied nutrient) management is a focus in all of our land use decisions; a number of excerpts are included here to give the needed background and understanding. Given the volume of planning and resources that has gone into the production of the Forest Plan, looking at all aspects of the SBNF's work, the direct, indirect, and cumulative effects of the work, expansion beyond that which has already been designed and decided upon appears to be outside the scope of the Nutrient Management Plan.

If the RWQCB finds that additional information is required to satisfy the Lake Elsinore/ Canyon Lake (LE/CL) TMDL Implementation Task, the SBNF and CNF welcome comments. The SBNF and CNF believe that nutrient, soil, riparian habitat, and watershed management have been adequately addressed in the Forest Plan.

Applicable Laws, regulations, and policies

Organic Administration Act of 1897

`http://caselaw.lp.findlaw.com/scripts/ts_search.pl?title=16&sec=473`

Authorizes the President to modify or revoke any instrument creating a national forest; states that no national forest may be established except to improve and protect the national forest within its boundaries, for the purpose of *securing favorable conditions of water flows*, and to furnish a continuous supply of timber for the use and necessities of citizens of the United States. Authorizes the Secretary of Agriculture to promulgate rules and regulations to regulate the use and occupancy of the national forests, to establish penalties for violating those rules and regulations, and to execute, or cause to be executed, all laws affecting the National Forest System. The authority to permit, under regulations, use of timber and stone includes the use of National Forest System lands to qualified parties for collection of vertebrate and invertebrate fossil resources. The Act also directs making provisions for the protection of national forests against destruction by fire. (*emphasis added*)

The National Environmental Policy Act of 1969 (NEPA)

The National Environmental Policy Act (NEPA) is our basic charter for protection of the environment. It establishes policy, sets goals, and provides means for carrying out the policy. NEPA procedures provide the direction to help public officials make decisions that are based on the understanding of environmental consequences, and take actions that protect, restore, and enhance the environment. NEPA procedures also require that environmental information is available to citizens before decisions are made and actions are taken that may affect the human environment. The Forest Service's Schedule of Proposed Actions (SOPA) is one way of providing information to the public. The Schedule of Proposed Actions is not intended to be a substitute for scoping and public involvement.

Current SOPA (June 2007) - relevant to LE/CL watersheds

Idyllwild Water District Sewer Pond Permit Renewal (CE)- scoping in Nov. 2006, implementation Oct. 2007

May Valley Hazardous Fuels Reduction (EA) - scoping est. July 2008, implementation May 2010; LEGAL - T5S R3E sections 19, 20, 27-32, 34-35; T6S R3E sections 2-4, 10.. Forested land southwest of Fleming Ranch, east of Hwy 243 and north of Highway 74/Johnson Meadow area.

May Valley Non-Motorized Trail System (EA) - scoping est Sept 2007, expected implementation May 2009; Create a system of non-motorized trails in May Valley utilizing existing non-system roads and trails.

Range Allotment NEPA (EA) - scoping start May 2007, expected implementation March 2008; Renew and/or issue 10-year term grazing permits for active cattle grazing allotments. Continued grazing on the Garner, Rouse & Wellman domestic livestock allotments and to add an additional pasture to Rouse allotment.

The US Forest Service-San Bernardino National Forest proposes to implement the 2005 Land Management Plan by authorizing continued grazing permits on three cattle livestock allotments on the San Jacinto Ranger District. The Garner Allotment is located about 3 miles southeast of the town of Idyllwild, Ca. The Rouse Allotment is located about 8 miles southwest of the town of Idyllwild, Ca. The Jim Burn pasture is currently officially a part of the vacant Paradise Allotment. However, it is used by the Rouse permittee as a temporary use pasture. It is located about ¼ mile north of Hwy 371 along Garner Valley, Ca. The Wellman Allotment is located between the eastern edge of Garner Valley and the Pinyon areas.

Thomas Mountain Fuels Reduction (EA) - Est. Objection Period Legal Notice 08/2007; expected implementation April 2008; Reduce fuels using a combination of hand, mechanical, and prescribed fire treatments over 10,000 acres in the Thomas Mountain area.

Vista Cell Phone Tower Special Use Permit - Alandale Station (EA) - Est. Scoping Start 09/2007; expected implementation October 2008; Decision to permit cell phone tower.

Vista Cell Phone Tower Special Use Permit - Lake Hemet (EA) - Est. Scoping Start 01/2008; expected implementation March 2008; Decision to permit cell phone tower.

San Jacinto Hazard Tree Removal (CE) - est scoping July 2007, expected implementation January 2008; Removal of hazard trees along roadway and recreation sites throughout the San Jacinto District. Approx. 500 acres. (http://www.fs.fed.us/r5/sanbernardino/projects/sanjacintord.shtml)

Dead trees near forest roads and developed campsites pose an imminent risk to life and property. They may also block an evacuation route in case of emergency. A Hazard Tree is defined as any dead or live tree likely to fail (entirely or in part) in the near future that is of sufficient size to reach a developed area of concern. Areas of concern include roads, developed campsites/campgrounds, structures, and private property.
In light of these risks, the San Jacinto District provides for the annual abatement of Hazard Trees. The number of Hazard Trees on the district will vary from year to year but there are several thousand trees that have recently been felled to abate the hazard. This project would remove these fallen trees or otherwise mitigate the fire hazard and other problems caused by these trees.

Watershed Protection and Flood Prevention Act of 1954

http://www4.law.cornell.edu/uscode/16/1001.html

Establishes policy that the Federal Government should cooperate with states and their political subdivisions, soil or water conservation districts, flood prevention or control districts, and other local public agencies for the purposes of preventing erosion, floodwater, and sediment damages in the watersheds of the rivers and streams of the United States; furthering the conservation, development, utilization, and disposal of water, and the conservation and utilization of land; and thereby preserving, protecting, and improving the Nation's land and water resources and the quality of the environment.

Water quality management for National Forest System lands in California – best management practices.

The practices, procedures, and program are in conformance with, and comply with the provisions and requirements of Section 208 and 319 of the Federal Clean Water Act (PL 92-500) and the United States Environmental Protection Agency (EPA) (g) guidance for the Coastal Zone Act Reauthorization Amendment. They are also within the guidelines of the Water Quality Control Board (Basin Plans) developed by the nine RWQCB in the State.

Pursuant to Section 208 of the Clean Water Act, all agencies responsible for carrying out any portion of a State Water Quality Management Plan must be designated as a Water Quality Management Agency (WQMA). Through the execution of a formal Management Agency Agreement (MAA) with the Forest Service in 1981, the SWRCQ designated the Forest Service (USFS) as the WQMA for NFS lands in California.

Organic Administration Act of 1897: This Act emphasized that the National Forests were created to improve and protect the forests; to secure favorable conditions of water flows; and to furnish a continuous supply of timber for the use and necessities of the citizens of the United States.

Multiple Use Sustained-Yield Act of 1960 and the Wilderness Act of 1964: These Acts stated the the National Forests are established and will be administered for outdoor recreation, range, timber, watershed, wildlife and fish, and wilderness purposes. The multi-resource management responsibility of the Forest Service is amplified through these laws.

Clean Water Act of 1972, as amended: This Act established goals, policies and procedures for the maintenance and improvement of the Nation's waters. It addresses both point and nonpoint sources of pollution and established or requires programs for the control of both sources of pollution. Section 208 required area-wide waste treatment management plans and water quality management plans for nonpoint sources of pollution. The Act established specific rules for Federal, state and local authorities in the regulation, enforcement, planning, control and management of water pollution. More directly, Section 319 addresses nonpoint source pollution and also requires development of water quality management plans.

National Forest Management Act 1978: This Act amended RPA, emphasizing interdisciplinary involvement in the preparation of land and resource management plans. The Act emphasized the concept of multiple use management and added requirements for resource protection.

The following actions will be used to carry our water quality management:

1) Correct Water Quality Problems on the national Forests
   a. NFS lands exhibit conditions that are, or have the potential to be, a source of nonpoint pollution. These conditions exist as a result of past management actions by the Forest Service, or other landowners, and as the result of natural occurrences such as fires and floods.
   b. These existing and potential nonpoint sources will be evaluated to determine the need for and type of treatments necessary. Those lands found to be in need of watershed improvement work will be scheduled for treatment as part of the ongoing work planning and budgeting process.
   c. Accomplishment is dependent on funding and personnel availability, and work priority relative to other management goals and objectives.
2) Perpetually Implement Best Management Practices
   a. Involves training, keeping BMPs current, and BMP monitoring and evaluation
3) Carry Out Identified processes for improving, or developing best management practices

The Forest Supervisor shall:

1) Apply BMPs for water quality protection and improvement in day-to-day management activities
2) Evaluate attainment of water quality management goals through formal and informal reviews of project planning, and through monitoring using BMPEP protocols
3) Conduct BMP training annually on an as needed basis, before each field season for new employees, new line officers, and new resource personnel.

Other Forest Service Policies

The Directives System is the primary basis for the management and control of all internal programs and serves as the primary source of administrative direction for Forest Service employees. The system sets forth legal authorities, management objectives, policies, responsibilities, delegations, standards, procedures, and other instructions.

The Forest Service Manual (FSM) contains legal authorities, goals, objectives, policies, responsibilities, instructions, and the necessary guidance to plan and execute assigned programs and activities.

The Forest Service Handbooks (FSH) are directives that provide instructions and guidance on how to proceed with a specialized phase of a program or activity. Handbooks are either based on a part of the manual or they incorporate external directives.

A supplement is any issuance which adapts or interprets higher level or external directives for national, regional, or local application. Many supplements listed below apply to the Pacific Southwest Region of the Forest Service (Region 5).

Clean Water Act of 1948, as revised and reenacted

http://caselaw.lp.findlaw.com/scripts/ts_search.pl?title=33&sec=1251

Passed to maintain and restore the chemical, physical, and biological integrity of the nation's waters. It requires compliance with state and federal pollution control measures; no degradation of instream water quality needed to support designated uses; control of nonpoint sources of water pollution through conservation or best management practices; federal agency leadership in controlling nonpoint pollution from managed land; and rigorous criteria for controlling pollution discharges into waters of the United States.

National Forest Management Act of 1976

http://ipl.unm.edu/cwl/fedbook/nfma.html

The National Forest Management Act reorganized, expanded and otherwise amended the Forest and Rangeland Renewable Resources Planning Act of 1974, which called for the management of renewable resources on National Forest System land. The Act requires the Secretary of Agriculture to assess national forest land, develop a management program based on multiple-use, sustained-yield principles, and implement a resource management plan for each unit of the National Forest System. Identification of areas suitable and available for timber harvest and determination of the allowable sale quantity from those lands is required. This is the primary statute governing the administration of national forests.

Forest Service Handbook – Soil & Water Conservation Practices

This supplement sets forth guidance for the delineation and management of Riparian Conservation Areas (RCAs) on the San Bernardino National Forest. This supplement works in concert with information contained in the 2005 southern California National Forests' revised land and resource management plans (forest plans).

02 - OBJECTIVE

1. To present practical, clear guidance for identifying, describing, and delineating Riparian Conservation Areas.
2. To aid assessments of multiple-use capability and suitability in Riparian Conservation Areas.

3. To establish a process for analyzing riparian conditions for the benefit of riparian-dependent resources during management actions within Riparian Conservation Areas.

Proper Functioning Condition. Riparian-wetland areas are functioning properly when adequate vegetation, landform, or debris is present to: dissipate energies associated with wind action, wave action, and overland flow from adjacent sites, thereby reducing erosion and improving water quality; filter sediment and aid floodplain development; improve flood-water retention and ground-water recharge; develop root masses that stabilize islands and shoreline features against cutting action; restrict water percolation; develop diverse ponding characteristics to provide the habitat and the water depth, duration, and temperature necessary for fish production, water-bird breeding, and other uses; and support greater biodiversity (Bureau of Land Management 1998 and 1999).

Riparian Conservation Areas (RCAs). An area delineated next to water features requiring special management practices to maintain and/or improve watershed and riparian-dependent resource condition

This Forest Service Handbook (FSH) supplement provides guidance for field personnel who manage streams and riparian resources at the site-specific project level. Information contained herein is to be used together with standards and design criteria found in the 2005 southern California national forests' revised land and resource management plans (forest plans). Riparian Conservation Areas (RCAs) include locations containing aquatic and terrestrial ecosystems -- lands adjacent to perennial, intermittent, and ephemeral streams as well as in and around meadows, lakes, reservoirs, ponds, wetlands, vernal pools, seeps, springs, and other water bodies. These are especially important areas because they are geographical areas where slope and fluvial processes are tightly inter-connected; terrestrial and aquatic systems strongly interact; and are important migration and travel corridors for many species. Land management activities have the potential to disrupt ecosystem processes and interactions resulting in adverse effects over the short and long term. Riparian Conservation Areas are managed to maintain or improve conditions for riparian-dependent natural resources. Activities should be (a) neutral, (b) move the area closer towards the riparian area desired condition, or (c) move towards the riparian management objectives defined in the forest plans. Watersheds are managed to maintain functioning riparian areas and improve or restore degraded riparian areas to proper functioning condition for native populations of riparian-dependent species.

Water of high quality flows from National Forest System lands and many uses depend on this water and forest riparian areas. Surface water attracts wildlife and livestock and is vital to human use such as for drinking water. Enriched nutrients and moisture create productive timber and forage sites. Gentle terrain, aesthetic values, and pleasant microclimates attract recreationists. Various stream characteristics provide the sole source for certain types of fishing and waterplay. Stream and riverbeds often contain valuable mineral deposits. Riparian areas thus can present both opportunities and conflicts for multiple-use planning.

RCAs include the following areas:

1. Perennial streams, intermittent streams, aquatic ecosystems, meadows and any other areas with riparian conditions (lakes, reservoirs, ponds, wetlands, vernal pools, seeps, and springs), floodplains and inner gorges.
2. Suitable or occupied riparian habitat delineated for threatened, endangered, proposed, candidate, and/or sensitive species.

Perennial streams not having identifiable riparian vegetation should still be managed under RCA guidance. Ephemeral channels carry water to intermittent streams and should be protected to the extent that they do not contribute substantial amounts of sediment and other deleterious materials into the system due to management activities.

Stream Protection Measures (Overview). A variety of forest management activities may occur within RCAs, both as planned activities and as emergency actions. The stream protection measures found in chapter 3, sections 3.21 – 3.38 of this FSH supplement apply to all RCAs. The measures are not intended to exclude streamside areas from management for forage, wildlife, water uses or other management activities. They are intended to assist in the design and implementation of projects that maintain and improve conditions for riparian-dependent resources.

Handbook Supplement covers activities for a variety of land use practices

3.21 - Stream Protection Measures General to ALL MANAGEMENT ACTIVITIES.
3.22 - General to Any Vegetation Manipulation Projects (other than Prescribed Fire described in section 3.23)
3.23 - Prescribed Fire Projects
3.24 - Vegetation and Fuels Management and Site Preparation
3.25 - Administration of Water Flow and Use
3.26 - Wildland Fire Suppression
3.27 - Wildland Fire Rehabilitation
3.28 - Law Enforcement Activities
3.29 - Administration of Recreation Uses and Special Designation Areas
3.30 - Road Construction and Maintenance
3.31 - Lands and Special Uses
3.32 - Administration of Prospecting and Mining
3.33 - Hazardous Materials...
3.34 - Livestock and Grazing
3.35 - Introduction of Species (Nonnative Wildlife and Plants)
3.36 - Hydroelectric Project Management
3.37 - Fish, Wildlife, Rare Plants and Watershed Management
3.38 - Facility Developments

SBNF Business Plan (2004)

The San Bernardino National Forest provides open space and recreational opportunities for the 24 million residents of Southern California. It also provides habitat for numerous species of threatened or endangered plants and animals.

Total Acreage (SBNF land) 671,686
Inholding Acreage 147,313

Unlike most other national forests, visitors come from within the SBNF's boundaries, too. Approximately 100,000 people live within the San Bernardino and San Jacinto mountains. Living within forest boundaries permits easy access to numerous recreation opportunities.

We currently face an unprecedented disaster of dead and dying trees, which creates the most serious catastrophic wildfire risk in the San Bernardino National Forest's history – with all the risks to public safety and species habitat that this implies. The wildfires of 2003 did not reduce this risk, but added new challenges in revegetation and flood prevention. As a result, restoration of the forest will be our top priority work for years to come.

As of September 2003, over 474,000 acres of the San Bernardino National Forest's 819,000 gross acres display significant vegetation mortality. Although over 140,000 acres burned in 2003, this had little effect on overall mortality. Vegetation impacted includes mixed conifer, oak woodlands, and chaparral. Mortality is near both developed and wilderness areas. In other words, the entire landscape, not just the developed areas near Lake Arrowhead, Big Bear and Idyllwild, is experiencing rapid vegetation mortality.

Over the longer term, the population of Southern California is expected to increase by 500,000 people per year for the next 20 years. Privately-owned open space is rapidly being converted to roads, subdivisions, and new communities. More and more people are turning to the forest, looking for solitude and outdoor recreational opportunities. The San Bernardino National Forest is adjacent to one of the great metropolitan areas in North America, the Los Angeles megalopolis. The 2000 census showed that nearly 16 million people lived in just the four neighboring counties of Los Angeles, San Bernardino, Orange and Riverside, with 24 million within a two hour drive of the forest.

Another risk is to the $7 billion in residential and commercial property within the forest. Property value along the increasingly dense urban interface is not included in the $7 billion. A third major risk is the destruction of threatened and endangered species and their habitats, watershed destabilization and the accompanying silting of streams, mudslides, and spoiling of recreation enjoyment.

The San Bernardino National Forest and other concerned agencies are not idly standing by. An estimate of $300 million over ten years is needed for wildfire prevention, hazardous fuels treatments, and future thinning and vegetation management in order to tackle this issue. On the surface this seems like an enormous sum, but the risks outlined in the previous paragraph show that the costs of not being proactive may far exceed this. The condition of the forest over the next decade will be defined by how the vegetation mortality issue is addressed.

Concisely, Resource Management sees to the health and sustainability of what is under, on, and above the land. Resource Management manages the health of the vegetation on the land, the quality of set aside wilderness areas, the boundaries and ownership of the land, the cultural heritage that resides on the land, the quality of the water running on and under the land, the air quality above the land, and the wildlife roaming the land.

2002: 9% of the resources budget (5% of overall budget) went to watershed, air, and geologic resources
2007: saw a 34% decline in watershed budget from 2006.

2002:
Given Southern California's water, air and geologic challenges, it is surprising to learn that a forest of over 800,000 acres and that produces 250,000 acre-feet of water spent only $174,577 and employed 2.1 FTEs (2006: now down to 1.25 FTEs). The program provides input into the activities of other programs, trains Forest Service staff on watershed management, surveys watersheds and geology for planning and decision making, and monitors water rights and air quality. Following the 2003 wildfires, the program must also monitor the effectiveness of treatments and respond to flood events. An additional $226,000 is needed to adequately support special use permitting, to plan and execute riparian and watershed restoration projects, to ensure that recreation is not taking place on sensitive areas, and to champion watershed, air and geologic components of the forest's Fire Plan.

Forest Plan

Record of Decision R5-MB-084, September 2005 (excerpts)

Alternative 4a includes a combination of program emphasis and active management strategies that will be used to conserve and restore the health of the forest. The existing uses on the national forest are expected to continue. Most of the development, such as roads, developed recreation sites, and administrative structures that might be expected to occur on the national forest, has already taken place. We do not anticipate much expansion of the Forest's permanent road system beyond what is currently in place, although Alternative 4a does not preclude the construction of a new road if conditions indicate the need.

The revised forest plan describes the strategic direction that assures the coordination of multiple-uses (e.g., recreation and environmental education opportunities, forest health and management, air, soil and water quality, watershed, and wildlife and the sustained yield of products and services [16 USC 1604(e)]). The revised forest plan fulfills the legislative requirements and addresses local, regional, and national issues. The FEIS discloses the environmental consequences of the alternative management strategies and how they respond to the issues.

Thousands of comments have been received since we began development of this revised forest plan in 2000. These included many comments about the agency's ability to effectively manage the national forest in light of recent trends in budget and a smaller workforce.

The revised forest plan is responsive to the Forest Service's 2004 National Strategic Plan and to the resolution of the four threats described by the Chief of the Forest Service (Publication Speech, 2003). These four threats include:

- **Fire and Fuels** – decades of fuel buildup, coupled with drought and disease, have created a situation that poses a real threat to the lives and property of people living in the communities of southern California. In southern California, fire is a fact; it is not a question if fires will burn, rather, it is a question of when and how intensive.
- **Invasive species** – Invasive species are spreading at alarming rates, adversely affecting people and the ecosystems of the San Bernardino National Forest.
- **Loss of Open Space** – The loss of open space (also known as 'fragmentation') has three aspects that challenge effective land management; (1) habitat fragmentation, (2) ownership fragmentation, and (3) use fragmentation.
- **Unmanaged Recreation** – The phenomenal increase in the use of the national forests for recreational activities raises the need to manage most forms of recreation, particularly the use of off-highway vehicles (OHVs). OHVs are motorized vehicles such as all-terrain vehicles (ATVs), snowmobiles, sport utility vehicles.

Executive Summary

Issues

The 'issues' are generally regarded as subjects for which resource conditions, technical knowledge, or public perception of resource management have created a "need for change." The issues by themselves would generally result in a significant amendment of the forest plans because the resolution of the issue could change the overall management direction for large areas of the national forests. The interdisciplinary planning team identified issues and grouped them into five categories after a review of the comments that were received in response to the public meetings and the notice of intent.

1) *Public use and enjoyment of the national forests is affected by intense competition among an increasing number of people for a finite amount of resources.*

This issue is focused on the ability of the four southern California national forests to continue to offer a variety of opportunities, experiences, uses, and national forest access to an expanding and increasingly diverse population, while at the same time providing appropriate resource protection.
The transportation system is valued for providing national forest access, delivering goods and services, wildfire protection, and recreation opportunities. National Forest road managers recognize that additional segments may be needed to increase the system's effectiveness, that other segments may require attention to resolve resource concerns, and that urbanization of lands along the national forest boundaries has closed off customary points of access to the national forests. The condition of existing recreation and administrative facilities has continued to decline due to diminishing budgets, which

greatly increases the facility maintenance backlog. At the same time, additional facility improvements are needed to address increased visitor demand.

2) *The trend of increased listing of threatened, endangered and sensitive species and the consequences of management actions on these species must be addressed.*

* *The present fire regime is out of balance, and the threat of wildland fire and risks to humans are increasing. Wildland fire is a critical issue on the four southern California national forests.*
* *A balance needs to be defined between the quantity of water extracted from national forest lands for human uses and the amount retained for ecosystem sustainability.*

The four southern California national forests include watersheds that are critical to providing the quality and quantity of water needed for the support of trees, plants, and wildlife, as well as for drinking water. The relationship between groundwater extraction, water diversions, and instream flow requirements to support aquatic species and riparian habitat is critical to the proper functioning of sustainable forest ecosystems and the recovery of listed species. The challenge is balancing the needs of water users with resource needs for the maintenance or improvement of riparian and wetland habitat.

3) *The increased demand for uses and products such as water extraction, oil and gas development and special forest products has intensified human pressure on the national forests.*
4) *Growing populations and expanding urban development are increasing pressure on national forest resources.*
5) *The designation of "special areas" offers protection of resources but can result in the reduction of current opportunities, experiences or uses.*

Forest Goals

1.1 - Community Protection - Improve the ability of southern California communities to limit loss of life and property and recover from the high intensity wildland fires that are a natural part of this State's ecosystem.
1.2 - Restoration of Forest Health: Restore forest health where alteration of natural fire regimes have put human and natural resource values at risk.
2.1 - Invasive Species - Revised forest plan standards would decrease the risk that invasive nonnative plants and animals become established on the national forests of southern California.
3.1 - Managed Recreation in a Natural Setting - Recreation visitation and use are expected to increase in all alternatives;
3.2 - Retain a Natural Evolving Character within Wilderness. - Visitor satisfaction in wilderness is gauged by the general level of development expected in adjacent areas and key indicators of how well the wilderness system can be expected to provide solitude, challenge and untrammeled ecological processes desired for these areas.
4.1a - Administer Minerals and Energy Resource Development while protecting ecosystem health.

4.2 - Infrastructure needed to transport energy into and out of southern California and between sub-regional areas is developed in designated utility corridors.

5.1 - Improve watershed conditions through cooperative management.

The watershed resource consists of surface water, groundwater, riparian areas, and the landscapes that make up the watersheds. Generally, adverse impacts on watersheds can be minimized or eliminated when all applicable measures (as described under the resource protection measures) are effectively applied.

5.2 - Improve riparian conditions.

Water and riparian resources receive protection from national forest management activities through the application of design criteria (standards) that would limit the extent and duration of any adverse environmental effects. Nevertheless, some adverse effects are unavoidable.

During implementation of this plan, some short-term adverse effects can be expected, but no long-term negative effects are anticipated.

6.1 - Move toward improved rangeland conditions as indicated by key range sites.

Annual and long-term monitoring of rangeland condition in key grazing areas would continue in all alternatives. Slow improvement in condition is anticipated based on forest plan design criteria and observed trends.

6.2 - Provide ecological conditions to sustain viable populations of native and desired nonnative species.

7.1 - Retain natural areas as a core for a regional network while focusing the built environment into the minimum land area needed to support growing public needs.

Numerous early laws that guided acquisition, disposal, reservation and management of public lands largely patterned the original land reservations for the national forests. The resulting ownership pattern of the national forests became one of mixed ownerships between public and non-public lands that still remain to this day.

Forest Plan FEIS

Alternative 4a is focused on the maintenance of healthy forests, community protection, managed, sustainable recreation setting and uses, and the management of threatened and endangered species. The alternative theme includes the opportunity for a low level of growth of recreation activities and the facilities to support increased use. Managed sustainable use of the national forests is compatible with the maintenance of long-term biological diversity and ecological integrity. The focus on community protection is complementary to the National Fire Plan.

The Watershed Management Program focuses on the maintenance of soil and water quality and quantity and the protection and/or the restoration of watershed health. Land disturbing activities such as development and maintenance of roads, trails, recreation sites, facilities, minerals and energy sites, vegetation management projects, WUI Defense zones, or other disturbed areas are designed to minimize impacts to soil and water resources. Watershed restoration projects are implemented to retain soil on site for the improvement of watershed health and the protection and/or restoration of riparian area function. Restoration activities involve using a combination of strategies such as rehabilitation of disturbed areas, protection of sensitive areas, environmental education, interpretive programs, Forest Service presence, and others. Monitoring is used to assess the implementation and effectiveness of proposed mitigation measures and restoration activities.

Riparian Habitats (page 98)

Instream water storage and diversions have dramatically reduced the extent of riparian habitats in this region. In fact, approximately 95 to 97 percent of low-elevation floodplain riparian habitat in southern California has been eliminated, and most major streams now contain dams or diversions. In addition, many smaller streams and springs have been dammed or diverted for water supplies and local flood control. Subsurface waters have been heavily tapped for domestic water, lowering water tables and base flows of many springs and streams (Stephenson and Calcarone 1999).

Watershed (page 196)

Composed of steep, naturally erosive mountains formed by dynamic geologic forces, the watersheds of the southern California national forests provide a relatively direct delivery system for precipitation and sediment to reach streams. National Forest managers play a unique and important role in water resources: responsibility for the headwaters and primary source areas for most of the major river systems in southern California, and control over the primary recharge area for most fractured-rock aquifers within the mountains. These river systems serve as ecological corridors that connect the mountains to the sea.

Horizontal instability (resulting from changes in discharge, sediment load and riparian vegetation) is often present in dryland braided river systems. On large alluvial fans, the plugging of channels with sediment and debris results in dramatic changes in the location of active channels (Graf 1988, Mount 1995). Rates of channel migration are highly variable and depend on the magnitude of storm flows and the resistance of channel substrate. In addition to horizontal instability, many dryland channels exhibit substantial vertical instability through entrenchment. In continuous channels, channel entrenchment can result from the rapid upstream migration of headcuts during large storm events (Graf 1988). In general, channel entrenchment is the result of some change in the amount and/or rate of delivery of water and sediment to the river channel. Three common types of causal mechanisms for the above changes include land management, climatic change, and internal adjustments (Graf 1988, Mount 1995). Although there is substantial debate in the literature regarding the causal link between specific land use changes and the associated physical processes that lead to channel entrenchment, many arid river systems can exhibit substantial vertical channel change during large storm events (Graf 1988).

The information above emphasizes natural changes in channel morphology that are typical of dryland fluvial systems. The combination of high intensity rainfall events, poor soil development, and steep slopes often generates high magnitude storm events that transform stream channel morphology and associated riparian habitat, which should be recognized when describing aquatic and riparian habitat areas and evaluating potential human impacts on stream channel morphology and aquatic and riparian habitat in southern California.

Heavy precipitation and flood events cause erosion and sedimentation, and naturally occurring chemical compounds found in the rocks can affect surface water quality.

While most water produced on the four southern California national forests meets or exceeds federal and state water quality standards, those waters that do not meet State Regional Water Quality Control Board standards (Clean Water Act, Section 303 (d)) can be designated by the state as "impaired." Impairments are alterations in water quality factors typically associated with temperature, sediment and chemicals. There are 34 state-designated impaired stream segments, lakes or reservoirs across the four southern California national forests (State of California 2003). These water bodies are usually found in low elevational areas, have associated floodplains, and have easy vehicle access and high use rates. **State listed 303(d) impaired waters will be considered during site-specific analysis as projects are proposed. Steps will be taken to maintain at least the existing quality of these waters. Opportunities to improve conditions will be identified and implemented as funding allows. (emphasis added)**

Surface Water - Uses (page 200)

The year-round demand for water is magnified by the large and increasing human populations surrounding and using the national forests (Davis 1998). The national forests provide domestic-use and drinking water for many southern California communities. Much of the water from forest streams is appropriated, meaning that the amount and location of the diversion is registered with the state; some watersheds are actually being adjudicated. Adjudication is a binding, court-approved allocation of specific amounts of water to specific persons within a watershed; adjudication restricts forest water uses. Large streams flow off the national forests, where the water is captured for private, municipal, industrial or agricultural uses. In 14 watersheds the current assigned water right exceeds 25 percent of the estimated annual flow.

Demand for national forest water extraction special-use permits is expected to increase in the future. The State Water Resources Control Board will rule a stream segment or watershed to be fully appropriated (that is, no water is available for new water rights applications) on a case-by-case basis. The demand for water is particularly apparent in the number of existing water rights associated with each watershed. Approximately 74 percent of the watersheds on the national forests have at least one water right filing; approximately 44 percent of all the watersheds on the four southern California national forests are being appropriated or adjudicated.

Intensive water use and management have resulted in a dramatic reduction in the extent and distribution of riparian and native freshwater habitats in this region. It has been estimated that 95 percent to 97 percent of riparian habitat in southern California coastal floodplain areas has been eliminated. In addition, much of what remains must function under a highly modified hydrologic regime including upstream dams that regulate streamflow. Clearly, no other landscape feature has been modified by human activities to the same degree as freshwater habitat (Stephenson and Calcarone 1999).

Preferential consideration is given to riparian-dependent resources when conflicts among land use activities occur. (page 206)

The National Forest Management Act requires that special attention be given to the land and vegetation for approximately 100 feet (~30.5 meters) from the edges of all perennial streams, lakes, and other bodies of water. This requirement is intended to protect riparian-dependent resources and stream water quality from adverse effects, primarily erosion and sedimentation, related to national forest management activities. On the southern California national forests, RCAs include this minimum required 100 foot (~ 30.5 meters) distance from the edge of water bodies and, in addition, also extend to include wider distances based on imperiled species habitat requirements and water quality protection needs determined over the past 15 years.

Riparian Areas - Uses (page 207)

Riparian areas are the locations where land management activities have great potential to disrupt ecosystem processes and interactions and can produce adverse effects. Management focus in these areas is on avoiding and minimizing potential management impacts. The cool temperatures, shade and water features found in riparian areas attract not only aquatic and terrestrial wildlife species, but humans and livestock as well. **To provide the conditions needed by riparian-dependent natural resources, these sensitive areas are managed to allow for uses that are either neutral or beneficial to the riparian conservation area (RCA).**

These areas are attractive to national forest visitors, as described in the Recreation section, and receive intensive pressure for day and overnight uses such as water play, picnicking, family gathering, camping, hiking, mountain biking and fishing. In general, effects depend on the timing of the use, sensitivity of the location, type of use and intensity and specific behaviors of the recreationists. The primary national forest management activities that affect the condition of surface water, riparian conservation areas and groundwater include: fuels and vegetation treatment; recreation use and development; road and trail construction and maintenance; water extraction and management; mining; other special uses that occur streamside such as recreation residences and organization camps; special land use designations such as research natural areas, wilderness and special interest areas; grazing; unauthorized activities; and watershed restoration. Effects from ground-disturbing activities can include but are not limited to soil compaction, stream channel degradation, increased erosion, and sedimentation. Vegetation treatments have potential to remove or destroy riparian vegetation and to affect water quality when herbicides are used. Water extraction and diversion can result in long-term effects by altering the quantity and quality of streamflows and by affecting a channel's capacity to carry normal flows. Watershed restoration treatments (such as riparian vegetation restoration, stabilization of sediment sources, and restoration of abandoned mine lands) are designed to improve conditions for riparian-dependent resources.

As standard operating procedure, management activities are designed to avoid riparian conservation areas or allow minor encroachments and proactive riparian treatments based on site-specific project-level planning. Routine applications of measures that protect water quality and riparian conservation areas—such as those in the Water Quality Management for National Forest System Lands in California, Best Management Practices Handbook (USDA Forest Service 2000), Best Environmental Design Practices (see Landscape Management), and environmental protection stipulations—are incorporated into special-use permits, contract specifications, and field operation plans for all management activities. In addition, the effects of wildland fire are minimized using resource advisors assigned to the fire, and the associated flooding is mitigated through the Burned Area Emergency Response (BAER) process.

Groundwater (page 209)

Initially, the national forests of southern California were established as "watershed forests," in large part to ensure more favorable water flows. Now, with heavy population demands for use of forest resources, and with the value of water constantly increasing, the balance between the maintenance of water for forest resource needs and the extraction of water for human needs can be controversial. When water is pumped from private wells adjacent to national forest boundaries, or within in-holdings or corridors, a large amount of that water could be coming from aquifers beneath National Forest System lands. Those extractions could be adversely affecting national forest resources but the degree of impact is usually difficult to quantify.

Adjacent developments that are potentially affecting national forest groundwater supplies, especially on the Angeles, Cleveland and San Bernardino National Forests, include water bottling operations, golf courses, ski areas, casinos, housing projects, and other recreational developments. For special uses on National Forest System lands, groundwater impacts are addressed during screening and application analysis processes.

Groundwater is a limited renewable resource because of the slow rate of groundwater movement through bedrock, the human dependence on groundwater sources, the decline in aquifer levels during extended drought cycles, the dependence on recharge from seasonal precipitation, and the restricted storage capacity of the bedrock. The potential for the overdraft of groundwater is already recognized within some areas on National Forest System lands, especially adjacent to national forest boundaries where development is encroaching, and on inholdings and areas with intermixed private and National Forest System lands. At this time, information is limited to assess the effects of Forest Service and off-forest uses and proposals for groundwater developments.

Geology (page 225)

The San Jacinto and Santa Rosa Mountains have a core or basement of granitic (quartz diorite plutons) rocks; some metamorphic (banded gneiss) and metasedimentary rocks; and minor amounts of younger sedimentary rocks and valley fill deposits. These rocks were compressed (squeezed up) between the San Jacinto and Banning faults, both considered active. The San Jacinto and Hot Springs fault zones and various associated sub-parallel faults pass through the western and southern portions of the San Jacinto Ranger District. Landslides are common in the San Jacinto River area but absent in much of the rest of the district. However, rockfalls are common on the north and east sides of the San Jacinto Mountains. Past mineral prospects include gold, tungsten, tourmaline, feldspar, quartz and marble.

Social and Economic Development (page 230)

The increases in regional population and community development immediately adjacent to national forest boundaries have a number of foreseeable management impacts within the national forests themselves. Demands will increase for corridors across the national forests for transportation, water and utilities to support the urban infrastructure. In addition to current extensive use of national forest mountaintops for electronic sites from which signals can be radiated over long distances, there will be a need for cell phone sites along transportation corridors. **Because surface water sources are fully used, there will be continued demand for additional groundwater withdrawals.** The proximity of communities will require formation of fire safe councils and prioritization of fuels treatments in community defense zones to reduce the danger of the spread of fire from the national forest to the community and vice versa. Demands will increase for recreation and other special-uses requiring facilities tailored to population diversity, with an emphasis on access.

Sheer population pressure combined with a lack of substitute open space has resulted in more instances of depreciative behaviors. Some examples are loud music, graffiti, broken gates, bullet holes in signs, **and unauthorized cross-country trails that are unmaintained and prone to erosion**. Finally, the economic profitability of illegal drug cultivation and transmigration of undocumented workers is an external socioeconomic condition that inevitably creates conflict on public lands.

Recreation (page 244)

Recreation is currently the predominant use of the national forests. For year-round use, these urban national forests rank among the top in the nation. Almost all visitations to southern California national forests are local in origin (Richer and others 2002). With the exception of the Big Sur area of the Los Padres National Forest, these national forests are not national destinations for multi-day vacations. Instead, they are primarily very popular local day-use attractions, often for large, diverse urban groups of extended family and friends engaging in relaxing activities.

Intensive, all-season recreation leads to resource and habitat impacts and a struggle for the Forest Service to maintain environmentally sustainable recreation opportunities. Competition for space, visitor group and community conflicts, and deterioration of facilities and areas occur in many parts of the national forests.

Rapid urban development is occurring adjacent to and within national forest boundaries, leading to use pressures (such as "social" trails) and resource impacts. Urban social problems are migrating to this nearby open space, leading to public safety concerns.

Visitor expectations are higher than in some parts of the country. More amenities are expected, such as recreational vehicle utility hook-ups, flush toilets and hot showers.

Roads (page 275)

Most southern California national forest roads were constructed by the Civilian Conservation Corps (CCC) in the 1930s for fire and watershed protection. Many have historical significance and are narrow, steep, native-surfaced travel ways with few if any turnouts and minimal drainage features. These low standard, high clearance NFSRs are typically categorized as ML 2 roads. They constitute most of the NFSR miles. Neither the amount of use these roads currently receive nor the size of today's wildland fire engines were anticipated in the 1930s. As a result, there is a failure of road maintenance budgets to keep up with inflation and road deterioration, road conditions on the national forests have fallen below the levels necessary for resource protection, and many cannot efficiently support the traffic volumes being carried. About one-third of the total ML 2 road mileage has points of difficulty for the latest generation of wildland fire engines.

Non-motorized trails (page 281)

The non-motorized trail system is an important part of the Dispersed Recreation Program. These trails provide visitors with an opportunity to access the national forest backcountry, whether for a sedate afternoon nature walk, a vigorous mountain biking adventure or a challenging multi-day backpacking trip. Visitors generally leave from trailheads and participate in trail-based nature viewing, camping, hunting, fishing, snowshoeing, cross-country skiing and birdwatching. Some people use trails just for the challenge and exercise. The southern California national forest non-motorized trail system is generally managed for the multiple uses of foot, equestrian and mountain bike travel. However, not all of these uses are accommodated on all trails at all times.

Forest	Miles of System Trails	Motorized Trails	Non-motorized Trails	National Recreation Trails	Pacific Crest Trail	Unclassified Trails
San Bernardino	452	38	414	13	160	52

For the past three years, approximately 10 percent of the trail mileage received annual maintenance such as brushing, trail tread work (culvert cleaning, water bars, etc.), and hazard tree removal. Approximately 5 percent of the trail mileage is maintained to standard. Maintenance accomplishments vary by national forest. Construction and reconstruction are accomplished incrementally as funding through the capital investment program (CIP) allows. Since the last forest plans were written, the network of non-motorized trails has slightly increased.

Motorized Trails (page 283)

229,193 acres managed for motorized use
160 miles road, 38 miles trails for OHV

The four southern California national forests have approximately 1,767 miles of objective ML 2 roads that are open for use by highway-licensed vehicles. This portion of the National Forest System roads offers access for a wide variety of recreation experiences, but also provides opportunities for 4WD use and operation. All four southern California national forests offer "genuine" 4WD opportunities, where the appropriate type of vehicle combined with driver experience is required to negotiate the difficult driving conditions that may be encountered.
560 miles ML 2 roads on Forest, 112 miles managed as 4WD opportunity

Wildland Fire and Community Protection (page 306)

Southern California is one of the most dangerous wildland fire environments in the United States. This region has had the most firefighters killed in action and residential structures lost of any region of the country. Some of the structural losses and most of the fatalities have occurred on National Forest System lands. In addition, a significant portion of past flood damages to low-lying communities have occurred as a result of debris flows and debris torrents coming from burn areas on the national forests; there have also been numerous fatalities associated with these flooding events (Wells 1987a, b). The fires of October 2003 resulted in fatalities of both civilians and firefighters, and additional civilian fatalities from down stream flooding several months after the fires. Median fire size has varied among the southern California national forests in the recent past. For example, between 1950 and 1989, the median fire size on the San Bernardino National Forest was 161 acres (mean 1,554), but it was 2,786 acres (mean 3,507) on the much smaller Cleveland National Forest (Weise and others, in press). Chaparral normally does not burn until it reaches approximately 25 years of age, but in southern California all but the very youngest age classes will burn at times of low fuel moisture and extreme fire weather (Keeley and others 1999a). Since 1910 and the advent of fire suppression, the number of fires per decade has increased in southern California; increases have been most pronounced in counties where human populations have exploded (Keeley and others 1999a). Interestingly, although the number of fires in chaparral has increased, mean fire size has remained the same over the roughly 90-year period (Conard and Weise 1998). This is largely due to successful suppression of fires that start in more moderate weather conditions and in more accessible locations, such as along roads. It also reflects the effectiveness of using fixed-wing aircraft and helicopters in extinguishing fires quickly in more remote locations (Moritz 1997). On the other hand, the frequency of large fires (greater than 50,000 acres) in chaparral apparently has not changed for centuries, through several distinct fire regimes: the Native American (before 1792), Spanish-Mexican (1792 to 1848), Anglo (1849 to 1929), and recent (1930 to present) periods (Mensing and others 1999).

Historically, large fires are common during two times of year. Most fires exceeding 20,000 acres burn between July and September during periods of high temperatures and low humidity. High rates of fuel consumption result in towering plumes of smoke that reach altitudes of 20,000 to 30,000 feet. These updrafts draw in air from the periphery of the fire, generating winds that further accelerate spread rates. In effect, these plume-dominated events create their own fire weather that results in large burn areas. During the past three decades, this type of fire has resulted in most of the acres burned on the national forests.

The other category of large fires burn from late September through February, when Santa Ana wind patterns follow the passing low-pressure systems and cold fronts. While fires that start in these wind patterns are normally of short duration (2 to 3 day fire events) and often produce fires in the 5,000 to 10,000-acre range, there have been historical fires attributed to Santa Ana winds that have burned more than 100,000 acres. There have also been a few cases of these winds lasting for extended periods. Firefighter fatalities and structural losses have been associated with both of these types of fires, with most of the historical structural losses in the region associated with Santa Ana winds.

National Forest System fire roads are also essential to successful suppression operations in southern California (Gucinski and others 2000). These roads have begun to deteriorate because of inadequate road maintenance budgets and the introduction of larger engines to fight fires. As a result, safety concerns for firefighters have increased. The fuelbreak and National Forest System fire roads represent a long-term investment related to minimizing wildland fire size and downstream flooding that may result from these fires. The evolution of fire suppression in chaparral has produced a firefighting culture that uses large numbers of fire engines to hold fires on roads and fuelbreaks under normal burning conditions and to protect large numbers of structures within and adjacent to Forest Service jurisdiction during extreme burning conditions typical of late summer and fall wildland fires.

Effects of Watershed, Soils, Air Quality, and Geological Hazards Management (page 341)

Soil and watershed restoration is carried out to correct problems caused by past land management or by natural events (e.g., earthquakes, wildfires). Watershed restoration projects are implemented to retain soil on site for improvement of forest health, water quality and quantity and riparian conditions.

Geologic hazards are identified, analyzed and managed to reduce risks and impacts where there is a threat to human life, natural resources or financial investment. This program should be beneficial to species-at--risk, and the results will not vary by alternative.

Watershed restoration activities will emphasize treatment of abandoned mines and landfills to improve water quality, stream condition and hydrology, and aquatic/riparian habitat. These treatments include clean up, stabilization and revegetation of disturbed areas within riparian conservation areas and adjacent uplands. Other projects may include closing, obliterating and revegetating roads; seasonal wet-weather closures to minimize rilling and erosion on roads; redesigning drainage structures on existing roads to reduce soil loss and stream sedimentation; stabilizing damaged streambank segments using vegetation and/or structural support; improving the overall vegetative condition of riparian areas; and removal of invasive nonnative plants. Although there may be some short-term negative impacts from certain projects, the long-term effects to species-at-risk are expected to be positive, especially for aquatic and riparian-dependent species. Gating and closing mines have been done for human health and safety as well as for the protection of wildlife species. Some abandoned mine tunnels have been gated in the recent past using gates designed specifically for the protection of bat species.

Effects on Watershed Conditions (P.426+) and Soils (P.444+)

Direct and Indirect Effects

Generally, adverse impacts to watersheds can be minimized or eliminated when all applicable measures as described under resource protection measures are effectively applied. Riparian conservation areas (RCAs) are not intended to exclude management but rather to protect areas of high importance and sensitivity that need strong consideration to maintain and improve conditions for water quality and riparian-dependent natural resources. At the project level, based on application of forest plan standards and site-specific condition analysis, activities may be conducted within RCAs.

Soil protection measures will continue to be implemented in order to assure the maintenance of soil quality and long-term productivity. These protection/mitigation measures are found in watershed analyses, environmental assessments, soil quality standards, and best management practices (BMPs) and are incorporated into the design criteria found in Part 3 of the forest plan.

Erosion results in the loss of the nutrient-rich surface organic layer and the productive upper layers of the mineral soil. Eroded soil particles sometimes degrade the water quality in streams and lakes or are deposited elsewhere to impact ecosystems. Mineral soil exposed and compacted from overuse by people and animals adjacent to streams and at remote campsites can be a serious consequence to other resources including fisheries and water quality.

Prediction of actual impacts on water, riparian, and soil resources will all be considered during site-specific, project-level environmental analyses as projects are proposed.

RCAs were used literally as buffers during modeling for this planning effort to determine a reasonable estimate of the remaining landscape acreages available for a variety of activities.

Off-forest developments, fire, vegetation management, road and trail management, mining and oil and gas operations, recreation activities and administrative uses of water can all affect groundwater and result in increases or decreases in water quantity and quality. Unless mitigated, the consequences can include less water available for human and resource use and reduced water quality, either short-term or long-term. National Forest managers will follow national and regional direction for water development and, where applicable, develop local management plans or guidance to preserve and protect sustainability of surface water and quality and quantity of groundwater and aquifers.

Alternatives that use increased amounts of groundwater may contribute to overdraft, because water levels in some wells are already dropping and groundwater resources are finite. Changes in demand for and use of both surface water and groundwater are likely to occur both on and adjacent to National Forest System lands in all alternatives. National Forest managers can control issuance of special-use permits for water uses on National Forest System lands by requiring analysis of environmental consequences of all extraction applications. Cleanup of contaminated aquifers, deteriorating wells, abandoned mines, oil fields and landfills will be a high priority under most alternatives. Water extractions occurring off-forest that may impact national forest resources can be assessed and contested by the Forest Service.

Pressures from increasing populations and national forest users are likely to increase levels of water use above current levels. On-forest consequences include reduced flow in streams, drying up of wells, groundwater contamination and habitat shrinkage. Off-forest extractions can cause the same consequences, especially near national forest boundaries and private in-holdings. The ability of the Forest Service to mitigate effects rests on the ability to adequately assess potential impacts and make decisions about granting permits for proposed or existing activities. The largest impacts will be from the largest and closest extractions, which will likely be water bottling operations and commercial developments near national forest boundaries. Consequences of on-forest uses are usually less pronounced, because extractions are relatively small; however, in aquifers with limited available quantities, even small extractions can be detrimental to sustainability of the aquifer. The number of special-use permits for groundwater use—including existing permits, new permits or proposed uses for on-forest recreation or administrative needs—is expected to increase in the next 15 years.

Alternative 4a. Watershed management under this alternative would be similar to Alternative 4, focusing on maintaining water quality and quantity and on protecting watershed health from the effects of limited growth in facilities and recreation uses. Management priority would be given to those areas where detrimental effects are occurring or where they could occur. Similar to Alternative 2, an adaptive management approach would be used for watershed protection. Restoration activities would be accomplished primarily at prioritized recreational use areas in association with environmental education and interpretation, hardening of recreation sites, increased Forest Service presence, and restriction of unauthorized uses. There may be a limited increased demand for groundwater at these improved recreation sites.

Effects of Vegetation Management on Watershed Conditions

Primary watershed impacts from vegetation, dead tree removal and fuels treatments generally come from the diversion and concentration of natural runoff along roads, landings and skid routes. Skid trails would compact soil or remove the upper, nutrient rich, soil layers.
On steeper slopes, water diversion can occasionally super-saturate soils and cause slope failures, which results in loss of long-term soil productivity and large transported sediment loads

When designed to enhance watershed conditions, proactive vegetation treatments within riparian conservation areas can serve to decrease the risk of total loss in the event of a wildfire.

Major increases in erosion from treatment areas are unusual because of ground roughness and downed vegetation available to contain sediment-ladened runoff. The exception is increased risk of erosion and sedimentation from road and skid trails associated with vegetation treatment activity.

Temporary roads are usually created for tree mortality harvest; these roads would then be obliterated and rehabilitated after mortality removal and reforestation are complete. The effects on soils are a short-term increase in soil compaction and erosion and a short-term loss in soil productivity.

Effects of Watershed Management on Watershed Conditions

Soil and watershed restoration is accomplished on an annual basis to correct problems caused by past land management or by natural events (earthquakes, wildland fires, etc.). Watershed restoration activities include treatments such as clean-up, stabilization and revegetation of disturbed areas within the riparian conservation areas and in adjacent uplands. Projects can include but are not limited to: closing, obliterating, and revegetating roads; seasonal wet-weather closures to minimize rilling and erosion on roads; redesigning drainage structures on existing roads to reduce soil loss and stream sedimentation; stabilizing damaged streambank segments using vegetation and/or structural support; improving the overall vegetative condition of riparian areas; and removal of invasive nonnative plants species. In particular, arundo (giant reed) and tamarisk (salt cedar) are invasive plants that are outcompeting native riparian vegetation, clogging the stream channels and, in the case of arundo, actually consuming large quantities of water in some streams on the national forests. These invasive species can be introduced to the national forests through a variety of different methods, but most commonly they are carried in by vehicles, equipment, and bike tires; through use of livestock and pack stock; and from adjacent lands. In all, these activities may result in short-term effects such as soil compaction, decrease in riparian vegetation (removal of nonnative plants), water quality degradation from herbicide application (daubing cut stumps of nonnative plants), increased erosion and sedimentation and long-term improvement in water quality. Disturbed areas within a watershed can be a result of past management actions or the result of unlawful activities such as unauthorized off-route travel by motorized or non-motorized equipment, or by dumping of trash and debris at shooting areas, undesignated day-use areas and along roads. They can also occur following criminal activities such as paraphernalia accumulation and disturbance from cultivation of marijuana, abandoned drug lab waste from active drug labs and other activities that have the potential to dramatically affect water quality and riparian areas.

Effects of Recreation on Watershed and Soil Conditions

Although only about two percent of the land base across the national forests is suitable for recreation activities, the demands placed upon national forest riparian areas for recreation use will continue to increase. In southern California, riparian areas and lakes, reservoirs and streams are the most sought-after locales for much of this recreation use. Water provides basic needs in campgrounds and other recreation sites. Most wilderness visitors also travel to and camp near lakes or streams. The availability of water enhances most recreational uses and, conversely, recreational pursuits have varying degrees of impact on these resources. Many developed and dispersed recreation sites, summer homes and organization camps are located near lakes and streams.

Because use is concentrated on the few available sites near water, over-use can reduce the health and vigor of riparian vegetation and compact soils. Recreation sites and riparian areas both have a limited capacity to meet the demands being placed upon them. Concentrated overuse typically affects riparian conservation areas; it results in trampling of streambanks and riparian vegetation, leads to soil compaction, and causes erosion and sedimentation. The risk of water pollution from human waste, dishwashing, trash accumulation and horse use is also higher where people congregate. In general, most areas across the southern California national forests experience only minor amounts of these effects, except at areas of concentrated use that are mainly associated with dispersed recreation. Although there is a component of year-round use composed mainly of dispersed use and hiking, most national forest visitation decreases between October and April when many developed campgrounds and day-use areas are closed for the winter season. Camping is not allowed within 100 feet of water bodies, and there are processes to assess current use of an area and to determine corrective measures when impacts do occur. Dispersed camping that takes place off-road has become an increasing problem that causes degradation to both riparian areas and streams.

Increased soil erosion and compaction from dispersed camping not only occurs from the campsite but also from the roads used to access the campsites. Disturbance from developed recreation is usually associated with road and facility construction and with concentrated use by people. Campgrounds, day-use facilities, administrative sites, parking lots and viewing sites are usually planned to remain for the long-term. These sites, along with associated permanent roads, vehicle parking and intensive use areas result in long-term loss of soil productivity.

When adverse changes in vegetation structure, fish and wildlife populations, stream channel stability or water quality indicate that habitat is declining beyond acceptable levels, the alternative is to use adaptive management techniques to modify, disperse, decrease or eliminate existing use based on the Adaptive Mitigation Protocol for

Recreation. In some cases the management options are limited and the challenges are compounded when there are no comparable areas nearby to which existing uses can be accommodated.

The emphasis in Alternative 4 on sustainable recreation through improvement of existing recreation facilities and/or by development of some new recreation facilities in high-need areas would potentially reduce existing riparian impacts and help minimize future degradation. Improvements and new developments would result in an increased demand for water, at greater rates than in the past, due to the more frequent installation of flush toilets and showers, except where water is already known to be scarce and recreationists are required to import their own sources of water. Alternative 4a also emphasizes sustainable recreation but provides for a slower rate of facility development.

Unauthorized vehicle use associated with dispersed camping could literally occur in all alternatives but is more likely to increase in those alternatives that emphasize access, such as Alternatives 4 and 5. Alternative 4 would likely result in more Forest Service presence or additional user restrictions to maintain sustainable recreation. Recreation uses that arise from improving or adding developed recreation facilities will result in additional demands for water. The need to develop more, larger or deeper water sources would increase, sanitation could decrease, and the potential for aquifer contamination and overdrafting would increase proportionally. Soil compaction from vehicles and concentrated use areas will cause small reductions in infiltration and increase runoff, resulting in less aquifer recharge. Other potential changes include alteration of local surface water temperature and chemistry; less groundwater availability to resupply surface water systems and riparian areas; and changes in rates of erosion, mass movement and soil creep. Indirect effects of water extractions just outside national forest boundaries in support of recreation activities can drain forest aquifers and take water needed by forest resources. Alternative 4a would limit to some degree the opportunities for unauthorized vehicle use associated with dispersed camping that could be anticipated in Alternative 4.

Overuse and unauthorized uses of riparian conservation areas by developed and dispersed recreation have a potential for affecting water quality, riparian habitat and the ability of the stream channel to function properly. Similar effects can result from overuse and unauthorized uses in open off-highway vehicle areas and along trails, including motorized, non-motorized, mechanized, pack stock, and hiking forms of recreation.

Effects of Law Enforcement on Watershed Conditions

As mentioned in different portions of this chapter, unauthorized activities that occur on the national forests can have detrimental effects on riparian conservation areas and water quality. Many of these activities are somewhat dependent on water sources, such as unauthorized water extraction for personal use or criminal endeavors like irrigating marijuana plantations. These extractions can interfere with a stream's hydrologic function and water quantity and quality, and they can cause habitat loss or degradation. Other unauthorized activities that generally can be considered ground-disturbing activities include off-route driving by motorized, non-motorized, and mechanized equipment, as well as dumping of trash and debris at shooting areas, day-use areas, and along roads. Those activities that affect water quality are described in potential effects on water and riparian resources from management activities tables.

As the population in southern California increases, the Forest Service can anticipate increasing numbers of national forest visitors and a related increase in the number of unauthorized and criminal activities. The effects from these activities are widespread and somewhat unpredictable. Control of effects will be heavily dependent on funding and staffing.

Effects of Roads/Trails on Watershed and Soil Conditions

Roads are the most significant source of increased sediment into stream channels on the national forests. Precipitation run-off from roads is a concern because of the efficiency with which it can reach a stream.

Soil disturbances can result from construction, reconstruction, maintenance and decommissioning of roads. The travel surface of roads eliminates soil productivity in the long-term. Cut-and-fill slopes or borrow ditches temporarily reduce productivity for the time it takes for vegetation to reestablish to the pre-disturbance state. Abandoned roads often result in chronic sedimentation or, in some instances, may wash out or fail altogether, resulting in a massive surge of sediment.

In an unroaded area, or when there is an adequate buffer between the road and the stream, run-off from rain or snowmelt typically infiltrates into the soil of a vegetated slope before it can reach a stream channel. This process is interrupted when a road traverses a slope and collects and diverts the run-off. If no effective mitigations are applied to disperse the run-off collected on a road, it can serve as a conduit where water travels down the road surface and flows directly into nearby channels, increasing the turbidity and rate of streamflow. In turn, the available energy of a stream increases, resulting in accelerated erosion of banks and the streambed. Generally, higher densities of roads within a watershed result in quicker run-off to the stream network and greater the risk of channel erosion and downstream sedimentation.

The primary water concerns in road management are location, design, layout and maintenance. When located adjacent to or across a stream, roads and trails can act as constriction points when flows are directed through undersized culverts and can serve as direct conduits of sediment-laden run-off into a stream, leading to sedimentation. Roads and trails constructed along an unstable slope can weaken its structure, resulting in landslides and creating a source of sediments from the disturbed material. Low-water road crossings (armored and unarmored fords, cement slab crossings, etc.) can disrupt streamflows, affect channel geometry and function and deliver sediment directly into the stream from the approaches to the stream crossing.

Inadequate distances or improper drainage between an unsurfaced road and a stream can produce additional sediment loading. Side-cast construction, unstable berms, poor quality surface aggregate or improper road maintenance can result in damage to riparian vegetation as well as increased stream sediment loads. These problems can persist long after a travel way is closed if measures are not taken to disconnect erosive run-off pathways into a stream channel and/or onto a road surface. Proper design and location of travel ways can significantly reduce the risk of damage from flood flows, slope failures, sedimentation and channel degradation. Each time a road is re-graded for maintenance, the soil is disturbed and perched on the roadside as berms, resulting in increased potential for erosion and sedimentation into nearby streams. Roads are a major source of erosion because of the extent of exposed soil on the road surface, cut slopes, fill slopes, and berms and ditch lines. Unpaved, they are vulnerable to rainfall and run-off that erodes their surface. Native-surfaced and gravel-surfaced roads are often severely damaged in the fall and winter following wet weather when visitors attempt to access National Forest System lands with their vehicles. Paved or unpaved, they serve to accelerate run-off, which when concentrated can cause erosion on unprotected down slope surfaces. In addition, without any means of detention such as vegetation or downed material, water coming off roads can efficiently convey sediments into a stream system. To prevent a direct delivery of sediment into a stream, run-off must be diverted either onto a stable and well-vegetated slope or into an adequately sized sediment basin. Greater distance between the road and the stream generally results in less sediment delivery to the channel (MacDonald pers. comm.). Once sediment enters a drainage network, either an ephemeral channel or perennial stream, it will be transported through the system as streamflow rates allow. Most roads (1930s CCC era) and trails were built prior to the adoption of the current watershed conservation practices. Priorities for road maintenance are set annually based on resource protection criteria and annual budget. Roads maintained by the national forests range from native surface to gravel and paved. Of the total 3,780 miles of National Forest System roads, 440 miles are paved. Many of the native-surfaced roads are managed using traffic restrictions during wet weather and temporary closures to protect the road surfaces from degradation. Other travel ways within the national forest include about 1,755 miles of user-created roads and trails, which have been inventoried but are not managed within the national forest's official transportation system. Some of these travel ways are wider than 50 inches and thus are considered roads; the remainder is trails. Restoration of riparian conservation areas may include obliteration or relocation of roads away from stream channels, riparian areas, steep slopes, high-erosion-hazard areas and areas of mass movement. Realignment of roads and other travel ways to cross riparian areas and streams at a perpendicular rather than acute angle also reduces chronic sedimentation and improves the quality of riparian and aquatic habitats in presently affected stream reaches. Road reconstruction may be necessary to provide stable cut-and-fill slopes and adequate drainage that will allow run-off to be filtered through vegetated buffers or sediment traps before entering the stream channel. Effective seasonal road closures are also a viable management tool that can reduce severe road damage from ruts and serve to maintain a road's integrity, thus reducing road maintenance needs while decreasing riparian and water quality impacts.

The proliferation of unclassified roads and trails by off-road vehicle travel is an ongoing problem and results in unacceptable effects to soils and other resources. Of particular concern is the potential for an increase in the unclassified road and trail network associated with the dead tree removal on the San Bernardino National Forest and to a lesser extent on the Angeles and Cleveland National Forests. Skid trails and temporary roads offer easy access into the national forests where this activity is located adjacent to mountain communities.

Emphasis would be placed on maintaining the quality of water, riparian areas and soil stability. Proper road design and maintenance and other techniques mitigate negative effects on resources from roads. Under all alternatives, planned sediment disposal sites beneficially affect roads by avoiding the emergency placement of sediment from road/slope failure onto inappropriate sites that may cause further loss of road infrastructure and negative effects on other resources. Seasonal closures for native, surfaced roads to protect the watershed and soil resources would continue in all alternatives.

Effects of Non-Recreation Special Uses on Watershed & Soil Conditions

As the population in southern California increases, we can anticipate an increasing interest in water impoundments for both hydroelectric generation and for municipal, agricultural and industrial use. Soil disturbance from development related to special use authorizations is likely to increase in all alternatives as demand for urban infrastructure support to communities increases.

Reservoirs can increase groundwater levels above and immediately below the dam site, and water flows can be managed to increase or decrease streamflows and groundwater levels downstream during different times of the year (Berg and others 2004). This generally is advantageous to groundwater flow and riparian sustainability, if managed for that purpose. However, riparian vegetation can encroach on stream channels when water is managed for very low flows and can cause reduced channel capacities. Diversions that remove water from an area can lower groundwater tables and surface water flow, which in turn affects habitats, riparian resources and other resources.

In Alternatives 4, 4a, and 5, the increased demand for water as a high value and scarce commodity will cause competition for these scarce resources. Potential overdraft of aquifers, with accompanying reduction in surface water and groundwater quantity, can result in a reduction in water availability to national forest resources. Overdrafting can occur in bedrock fracture aquifers, alluvial aquifers or deep porous and permeable rock zones. It results primarily from pumping from vertical wells or withdrawal of water from horizontal wells, at a rate greater than that which is naturally, or in some cases artificially, replaced by aquifer recharge. Within or near the national forests, potential sources of overdraft are water wells for campgrounds, recreation residences, snowmaking and water bottling operations, administrative sites, range and wildlife sources and nearby agriculture and urbanization. In general, the more wells that tap an aquifer, and/or the more water pumped, the higher the likelihood of overdraft and the more likely that surface resources would be affected, especially riparian areas, springs and meadows. If more water is kept on-forest to maintain forest vegetation, keep aquifer levels high, support streamflow and riparian area integrity, support wildlife and grazing needs and provide drinking water for national forest recreationists, then less is available for down-gradient domestic, municipal, agricultural and commercial uses. Alternatives that use increased amounts of groundwater may contribute to overdraft. The Forest Service has little control over external water extractions, and the consequences will be similar in all alternatives. Indirect effects of water extractions just outside national forest boundaries from increasing urban developments and increasing commercial developments such as water bottling, can drain forest aquifers and take water needed by national forest resources.

Effects of Livestock Grazing on Watershed and Soil Conditions

Grazing can occur in and near riparian areas where forage, water and cover are in close proximity. Continuous season-long grazing in these areas during long, hot and dry months may result in deteriorated riparian systems and lead to water quality degradation if livestock are allowed to remain too long. The impacts can include vegetation type conversion, soil compaction, increased stream bed disturbance, physical destruction of aquatic habitat, bank chiseling, erosion and sedimentation, reduction and/or loss of wildlife and fish habitat and decreased water quality (Meehan and Platts 1978, Platts 1981). When the impacts of livestock grazing are substantial, modifications in the timing and/or amount of grazing activities can reduce the overall impact in critical areas. Removal of livestock or reduction of the season or number of livestock from the affected area typically remedies over-grazed areas (Schulz and Leininger 1990). Cattle grazing cause visual changes in oak-woodland spring structure. However, spring composition is stable over time, and hoof-caused hummocks do not result in detrimental changes to composition, productivity or water quality (Allen-Diaz and others 2004). Sensitive resources are protected through application of the design criteria in Part 3 of the forest plan, best management practices (BMPs), and permit terms and conditions that are designed to allow for moderate grazing that meet or move towards desired conditions.

Well-designed and implemented grazing programs can move rangelands that are functioning at-risk toward a condition where native plant communities occur in natural mosaic patterns and have relatively uninterrupted disturbance regimes. This can provide favorable conditions for soil hydrologic functions and watershed processes, as well as for associated aquatic organisms. These changes can result in improved soil, water, riparian and aquatic conditions. The degree of soil resource disturbance from grazing is expected to be directly related to the number of acres within grazing allotments.

Waterborne transmission of the pathogens is a water contamination concern. Livestock can contribute to the transmission of pathogens, along with humans and various wildlife species (Atwill 1995). In general, wildlife regardless of age including striped skunks, coyotes, California ground squirrels, and yellow-bellied marmots were substantial sources of *Cryptosporidium parvum* oocysts. In contrast, only the young stock of beef and dairy cattle were substantial sources of oocysts; adult cattle appear to excrete only limited numbers oocysts relative to either calves or wildlife (Atwill and others 2002). Compaction of soil, removal of vegetation, re-channeling of surface water along livestock trails and breaking down of streambanks can result in gully formation in sensitive areas and lowering of the groundwater table. While the concentration of cattle along stream banks during the dry season resulted in a significant increase in bare ground, researchers were unable to detect streambank erosion in a study on cattle grazing impacts on stream-channel erosion in oak woodlands. However, cattle trails are an important mode of sediment transport into stream channels (George and others 2004). The degree and location of the effects of livestock grazing are identified in a site-specific analysis and not at the forest plan level. Grazing that leaves adequate amounts of residual dry matter (RDM) in the uplands is generally not an important source of sediment (George and others 2002). Properly managed RDM can be expected to provide a high degree of protection from soil erosion and nutrient loss (Bartolome and others 2002). The design criteria in part 3 of the forest plans are in place to meet or move towards all desired conditions and minimize livestock effects.

Effects of Fuels Management on Watershed Conditions

Fuel loading on the four southern California national forests has increased over most of the century from densely vegetated stands and tree mortality. The potential for large, stand-replacing wildfires has grown substantially, especially in high-elevation forests where fire suppression has been most effective. Prescribed fire provides a means to burn under more controlled circumstances that determine a fire's location, size, timing and intensity. In most cases, the intensity of a prescribed fire is less than that of a wildfire, leaving more ground cover and reducing the potential for erosion. Management-ignited fires typically occur under wetter soil moisture conditions than exist at the time of wildfires. These conditions are preferable for avoiding the formation of water-repellent soils (DeBano 1981). The intent of prescribed burns generally is to reduce fuel loading without fire intensities so hot that they cause significant loss of vegetation or incur soil erosion or water quality problems. Areas with reduced fuel loading provide greater opportunities for more effective application of fire suppression techniques, sometimes limiting the size and severity of wildfire on the landscape. Reductions in downstream flooding, sediment and debris production are often seen in watersheds where prescribed fire has been used as watershed management tool. Low-intensity fires typically leave sufficient organic matter to protect the soil surface. In contrast, high-intensity fires can consume duff, litter and much of the vegetation. A high-intensity wildfire has a greater potential to burn through riparian areas than a prescribed fire. A prediction of the acreage of high-intensity wildfires that might be expected over the life of the revised forest plans was not made. However, the Forest Service can compare the impacts typically related to wildfire with those from prescribed fire treatments. The major differences between wildfire and prescribed fire are the percentage of the watersheds burned at one time, the overall burn intensities, and the unknown timing of heavy rainfall events. Prescribed burns are designed to emulate natural forest openings by creating a mosaic pattern of burned and unburned areas within each watershed. Treatments generally result in moderate fire intensities across most of the project area, with scattered sections of high-and low-intensity burned areas. Fuelbreaks are wide strips or blocks of land on which the native or pre-existing vegetation has been permanently modified so that fires burning into it can be more readily extinguished. The vegetation changes from one type to another, which is called a type conversion. Mechanical methods and hand labor are typically used to construct and maintain fuelbreaks. However, herbicide applications on fuelbreaks may be used to treat resprouts of chaparral and reduce maintenance costs. Long-term maintenance of fuelbreaks generally is done through the periodic application of fire on the average of once every five years. Construction of fuelbreaks can have effects similar to other ground-disturbing activities; however, these effects would be short-term. In some locations on the Angeles National Forest, fuelbreaks are maintained by grazing livestock. Although soil compaction occurs, mostly along major fuelbreaks, it appears not to affect vegetation regrowth, although on occasion it can intensify drainage diversion and erosion rates along the fuelbreak route. Unauthorized driving on fuelbreaks by vehicles, motorcycles and mountain bikes traveling off-route can cause rilling, rutting and gully formation and accelerated erosion. Fuelbreaks can directly lead to a reduction in downstream flooding and sediment yield by helping to limit the size of wildfires. They are strategically placed on the landscape for just that purpose, and under less than the most severe wildfire conditions significantly reduce the size of wildfires. A reduction in wildfire size within a watershed can be directly related to reductions of flooding, channel and debris damage that might occur in and downstream of that watershed. All alternatives are generally similar with regard to vegetation and fuels treatments and fuelbreak construction and maintenance. Mortality removal will generally be done on the periphery of towns and homes in WUI Defense and Threat zones within 1.5 mile of threatened communities, and along evacuation routes within 1/3 mile from public and permitted facilities and developed recreation sites. Alternatives 3 and 6 might provide a slightly smaller number of total fuelbreak miles constructed and maintained than the others.

All alternatives provide for prescribed burning relatively similar numbers of acres and should have similar watershed effects. Acreages of treatment represent both a short-term risk to watershed resources as well as a long-term protection measure from higher-intensity wildland fires. Consequences of dead tree removal and WUI zone treatment (mostly mechanical), forest health/thinning (some mechanical), fuelbreaks (hand, some mechanical, some chemical), and prescribed burning treatments tend to have overall beneficial consequences for water and riparian resources. Vegetation removal that reduces transpiration will leave more available water in the ground for stream recharge, other vegetation growth or riparian resources. However, these increases are short term and are not measurable in the long term at the watershed scale. In addition, if soils are hydrophobic, infiltration to aquifers will be reduced and runoff increased. Short-term reductions in riparian vegetation can result when prescribed fire enters the riparian conservation area. Disturbance of soil from roads, skid-trails and landings can cause increased landsliding, erosion and sedimentation. Vegetation and fuels management techniques, prescribed burning and mechanical removal of vegetation would not vary significantly among alternatives. Overall, short-term adverse effects on water and riparian resources would be slight to moderate, but the long-term benefit of reduced fuel loading and the risk of loss to a wildfire would be high.

Effects of Wildland Fire Suppression on Watershed & Soil Conditions

Wildland fire is a natural process in the ecosystems of southern California. The four southern California national forests average about 563 wildland fires per year. Wildland fires are mostly on the low- and mid-elevational band. Many of these fires originate adjacent to the national forest boundaries, often starting below the national forests and traveling up into National Forest System lands (see the Wildland Fire and Community Protection section). Fire prevention efforts such as Forest Service presence in the field, agency articles and new releases and environmental education can be effective at preventing human-caused fire starts. The severity of impacts from wildfire and prescribed fire on water and aquatic and riparian resources depends on the fire's intensity and the degree of any suppression efforts. Hot fires can eliminate the erosion protection afforded by vegetation and soil organics, which can cause increases in erosion, dry ravel and sediment transport caused by rainfall and sheet erosion; these can affect water quality. In some instances a hydrophobic (water-repellent) soil layer or impermeable crust is created, which can reduce the potential for short-term infiltration, increase overland flow, and greatly increase erosion and erosion effects. The loss of riparian vegetation removes the buffers next to the streams.

Effects of increased sediment in a stream will depend upon the composition of channel types within the watershed. Although most watersheds in southern California are over-steepened and have naturally-occurring water erosion, these watersheds can also experience an increase in dry ravel after wildland fires that can eventually make its way to the stream courses (Wells 1987b). Watersheds with high gradient channels will tend to flush the sediment out, whereas watersheds with a high percentage of low gradient channels will retain the sediment longer. Effects on channels generally include a reduction in sediment after the first three years. Landslides and downstream flooding from severely burned watersheds are also of concern where dwellings and other structures located in a floodplain are at risk (Barrows and others undated, Highland and others undated). Natural regrowth of forbs and other understory vegetation generally occurs rapidly, often with good coverage in place the following year.

Wildland fire suppression efforts can have impacts on watershed resources. Fire lines built with heavy equipment generally are constructed on ridgelines to assist in the control of wildfires. However, during initial attack, fire line construction typically can be indiscriminate with regard to sensitive riparian areas and erosive or unstable soils. Fire lines disrupt subsurface flows and can cause a direct delivery of these flows and precipitation run-off to the stream. Applications of fire retardant and Class A foam can have effects on water quality and on aquatic and riparian-dependent resources (Gaikowski and others 1996).

Wildland fire and suppression practices can result in soil baking or compaction, which leads to increased run-off, erosion and sedimentation and potentially to increased flooding. The development of rill networks and gully erosion increases post-fire soil loss during the rainy season when soils are wet or saturated. Infiltration rates are decreased on bare slopes; therefore, run-off or overland flow increases and sediment carrying capacity increases. This type of erosion results in the movement of sediment and debris into stream channels, causing clogged drainage ways, mudflows and debris flows. The higher rate of sediment runoff and debris loads increases the potential for flooding as a result of fire. Soil slippage can also occur during heavy rains when the amount of water entering the soil layer exceeds the capacity of the parent rock to transport water. This leads to supersaturated soils; soon the stress on the soil exceeds its strength, resulting in sloughs and slumps. After fires, even moderately heavy rainfall can supersaturate soils denuded of vegetation. Post-fire conditions can also result in reduced-stability landslides and other geologic hazards.

Effects of Watershed Condition Management on Roads

All alternatives emphasize the repair and mitigation of the effects of roads located in riparian areas, wetlands and uplands. Watershed condition analysis identifies the watersheds that roads are expected to affect the most. Mitigation options include seasonal closures, crossing improvements, rerouting roads and trails out of riparian areas, surfacing, storm water runoff protection and scour protection (Copstead and others 1998). [page 538]

As populations grow and urban development expands, the continuous use of National Forest System roads and trails will increase. There is currently a greater demand for a variety of recreation uses in both motorized and non-motorized settings. The arterial and major collector roads that connect the national forests to these areas will experience the most increased day-use traffic, particularly on weekends. This traffic adds to the maintenance work required but there is no additional funding to accomplish the work. National Forest System lands adjacent to population centers are affected the most by user-created trails that access the national forests from residential properties. As travel to and through the national forests increases, there will be more impacts on surrounding public roads. Many state and county roads through the national forests provide commuters access from homes to jobs. All types of recreation use will significantly increase in volume on the national forests. The level of heavy truck traffic has increased considerably in the protection zones near communities in the San Bernardino and Cleveland National Forests during tree mortality removal operations.

Under Alternative 4a, public motorized use would be restricted on 72 percent of all acres. Fewer fire starts are projected, heritage resources would be better protected, non-motorized recreation activities would be enhanced, and biodiversity would be improved. Permittees and landowners would take a greater role in maintaining their access where the public is not allowed on motorized vehicles. Motor vehicle effects to soils and watersheds should be reduced; however, closed roads without annual access needs would receive less maintenance than currently and may increase watershed impacts slightly. Opportunities for driving for pleasure would be slightly reduced in the Level 2 High Clearance Vehicle category.

Cumulative Effects

Water and riparian resources receive protection from national forest management under all alternatives through the application of design criteria (standards) that would limit the extent and duration of any adverse environmental effects. Nevertheless, some adverse effects are unavoidable. The possibility for damage to the riparian ecosystem is greater in those alternatives with more ground-disturbing activities (such as road building and reconstruction, recreation facility construction and commodity development), such as in Alternative 5 and somewhat in Alternative 4 and 4a. The resource protection measures described above should prevent widespread or long-term deterioration of water or riparian resources. During implementation of this plan, some short-term adverse effects can be expected, but no long-term negative effects are anticipated. It is impractical to complete a cumulative watershed effects analysis at the scope and scale of this strategic level of forest planning. Cumulative watershed effects analyses using the USDA Forest Service, Region 5 methodology (FSH 2509.22) will be developed and discussed at the project level. Potential cumulative effects on water and riparian resources resulting from past, current and future management are based on the total amount of disturbance. The same watersheds where management activities historically have been concentrated would continue to incur most of the activities under any of the alternatives. Nearly all the management activities conducted on the national forests have the potential to affect water resources. Their cumulative effect on a watershed depends upon the effects of past and present management as well as the watershed's inherent ability to absorb additional disturbance to its biological and physical processes and elements. The impacts of management activities on watershed health can be detected by assessing the conditions of its water and riparian resources. As such, these resources are excellent indicators of cumulative effects. Presently, most of the national forest watersheds are rated as being in good to moderate condition. As previously stated, where multiple ownerships exist in a watershed, the Forest Service will work with the appropriate agencies, communities and individuals to protect and restore and watershed resources. High-risk watersheds will be evaluated and prioritized for rehabilitation based on feasibility, funds available and overall benefits to watershed health. Activities that have a higher risk of adverse watershed effects include water extractions; water diversions (blocking of channels); removal of vegetation; recreation facility development and use; mining; and high linear feature density (roads, trails, fuelbreaks, power transmission and pipelines and trans-basin diversions and tunnels). Some watersheds experience many of these effects, underscoring the need to take into account their cumulative effects. The cumulative effects of management activities and the expansion of urban populations toward National Forest System lands trend toward increased pressure to develop more groundwater resources, both on-forest and adjacent to National Forest System lands. The results are increased risks of damage to groundwater quality, decreased levels of groundwater availability, and increased costs of developing and maintaining deeper and larger wells. An increase in water diversions and impoundments can affect water quality and the functioning of streams, ponds, lakes and wetlands. Potential cumulative effects as a result of water put to beneficial use through diversions of surface water would depend on the demand for future water rights. Substantial diversions from forest streams occur at this time for public water supply and hydroelectric projects, and additional new proposals are expected. Adverse effects on riparian-dependent resources have occurred at existing sites, and additional diversions would increase these effects.

Most special designation areas on the national forests are virtually untouched by roads or large-scale management activities and generally retain pristine watershed characteristics. Increased recreation resulting from expanded population growth can lead to increased trail density, trampling and degradation of riparian areas and other activities that threaten watershed health, especially in popular locations. These activities may limit management options in watersheds of mixed ownership where watershed condition and water quality is of concern. Based on ground disturbance, implementation of Alternative 5 would have the highest risk of adverse cumulative effects on the water and riparian resource and overall watershed condition. Alternatives 1, 2, 4, 4a, 3, and 6 would each follow with successively fewer impacts.

Projected population growth throughout all of southern California is expected to bring major increases in pressure upon national forests' natural resources, including development and use of resources to support community growth (such as water, energy and transportation). The potential pressure on the national forests to provide access and recreation opportunities for these new communities could greatly affect resources on the national forests, especially soils. Counterbalancing the urbanization trend surrounding the national forests is the increased value of National Forest System land as undisturbed open space within the urban landscape and as species habitat. Management guidance associated with protecting and even restoring habitat for threatened, endangered, proposed, candidate and sensitive species could negate or severely limit further development of transportation and utility corridors to support urban populations. This is true in all alternatives. Increased urbanization does have a high potential to result in an increase in unauthorized use experienced by the national forests, which could have the potential to damage national forest soils. The amount of activity and the location determine the general and cumulative effects.

Land Management Plan

Part 1 - Southern California National Forests Vision

Introduction

The revised land and resource management plans (forest plans) for the southern California national forests describe the strategic direction at the broad program-level for managing the land and its resources over the next 10 to 15 years. The strategic direction was developed by an interdisciplinary planning team working with forest staff using extensive public involvement and the best science available. The revised forest plans have a focus that is different from the old forest plans. The revised forest plans are outcome based and are focused on the condition of the land after project completion rather than the products removed from the land. Each forest plan is directed toward the realization of the desired conditions using strategies that are consistent with the concept of adaptive management and sustainable resource use.

The revised forest plans are grounded on the concepts described by the Committee of Scientists in their report, *Sustaining the People's Lands (Committee of Scientists, March, 1999)*. Paraphrasing the committee's report, the term sustainability includes three components: ecological, social, and economic. Sustainability means meeting the needs of the present generation without compromising the ability of future generations to meet their needs. The concept of sustainability is old; its broadened interpretation and redefinition should be viewed as a continuation of the attempt by Gifford Pinchot and others that followed him to articulate the meaning of 'conservation' and 'conservative use' of the lands and waters of the national forests. Therefore, the revised forest plans are designed so that managers have the flexibility to adapt management strategies to the constantly changing demands that are inherent to natural resource management. The strategic direction is expressed through an overall vision of what is wanted, the strategy for accomplishment, and the design criteria that will be used as activities are proposed, analyzed and implemented.

The forest plans were prepared according to the requirements of the National Forest Management Act (NFMA), the National Environmental Policy Act (NEPA), and other laws and regulations (Appendix A). The current forest plans for the southern California national forests were approved between 1986 and 1989. NFMA regulations require that each forest plan be revised every 10 to 15 years (36 CFR 219.10). The revised forest plans have been prepared to meet that requirement.

The forest plans were developed to implement Alternative 4a (selected). Alternative 4a (selected) represents the adjustment of the preferred alternatives identified in the draft environmental documents. The accompanying Final Environmental Impact Statement (FEIS), describes the analysis used in formulating the revised forest plans.

Vision

The southern California national forests provide a balanced and sustainable flow of goods and services for a growing diverse population while ensuring long-term ecosystem health, biological diversity, and species recovery. The national forests also accommodate changing trends in visitor use through outreach efforts, facilities and education that meet the needs of emerging population demand.

National Forest watersheds are managed to provide many benefits including flood protection and quality drinking water for downstream communities, as well as protection of Wildland/Urban Interface (WUI) areas from wildland fire. They also offer a haven for native plants and animals, and provide unique and irreplaceable habitat for threatened, endangered, and sensitive species.
The national forests offer an escape from busy urban life by providing much-needed open space and a wide variety of recreation opportunities. They serve as an outdoor classroom, a 'living laboratory,' for learning about our natural and cultural heritage and the importance of conservation.

On a regional scale, the national forests: serve as quality, low-cost, local source of water consumed by the urban population of southern California. The national forests continue to serve as a recharge area for numerous reservoirs and groundwater basins that provide water for numerous communities, and for agricultural and industrial uses.

Management Challenges

Maintaining healthy, sustainable national forests in southern California is affected by a complex set of factors including population growth, rapid urbanization, recreation use, access, drought, disease, tree mortality, fire, exotic pests and invasive non-native species, and protection of natural resources. For the sake of brevity, these factors are addressed in three major categories: urbanization, fire, and natural resources. The health of the southern California national forests depends on our ability to meet these challenges, while at the same time maintaining forest and community sustainability.

Management challenges related to urbanization include:

- accommodating the demand for a wide variety of water uses with a limited supply of water in one of the driest climates in the United States. The demand for water for community, commercial, or private use has resulted in numerous impoundments, diversions and wells. Finding the delicate balance between peoples' need for water and the water necessary to sustain healthy riparian habitat and wetlands in the national forests will continue to be a challenge. Healthy, stable, and resilient watersheds absorb rain, refill aquifers, cool and cleanse water, slow storm runoff, reduce flooding, and provide important habitat for fish and wildlife. Water users include people (who are particularly attracted to water because of hot temperatures and the arid climate), downstream cities and communities that use the water for municipal water supplies, as well as the numerous plant and animal species that depend on water for their survival. The demand for water can only increase as the population increases. Water is a complex challenge as the existing above-ground sources may be fully used and subsurface (groundwater) supplies are at a minimum heavily tapped for municipal or private water or for commercial uses (water bottling). Maintaining the quality of water is a challenge because of the intense levels of human use, air pollution, or natural events such as landslides, flooding and post-fire erosion. Managers are challenged to improve impaired watersheds.

Fire

Wildland fire may be the biggest challenge forest managers and the public face over the next couple of decades. Fire is a fact of life in southern California. Fire is not a question of if, rather, it is a question of when and how much damage. Fire staff have concluded that under the right conditions, a fire started anywhere on the four southern California national forests may be a threat to adjacent communities. The four southern California national forests include over 3.5 million acres with thousands of structures in or around their borders that are threatened by wildland fire. The national forests are also located in one of the driest, most fire-prone areas in the United States. The situation is compounded by decades of fire suppression practices that have resulted in the development of unnaturally dense stands of trees and the accumulation of brush and other flammable fuels in many areas. Housing and other development adjacent to national forest boundaries is increasing at a rapid rate without adequate provision for the development of a 'defensible' space around them. Further compounding the complexity of the situation is the recent drought and insect infestation that is centered on the San Bernardino National Forest, but may be spreading toward the Angeles and Cleveland National Forests. Dead trees in and around communities and homes are an immediate challenge.

Management challenges related to wildlife and plants include:

- finding solutions to problems in freshwater aquatic habitats and montane meadows, which are relatively uncommon in southern California and have been substantially modified by dams, diversions and erosion. These areas support a large number of species of concern and are also places where people like to recreate because of water, shade, and cooler temperatures.

Goal 5.1 - Improve watershed conditions through cooperative management.

The national forests generally provide the headwaters and primary source areas for most of the major river systems in southern California. Streams and rivers offer habitat to numerous aquatic and riparian dependent species-at-risk found on all of the national forests; in addition to providing water for municipal, commercial and agricultural uses off of the national forests. Watershed conditions, or watershed health, on the national forests vary depending upon the amount of disturbance that has occurred within each watershed, and the effect of the disturbance on the natural integrity of the watershed as a whole.

Watersheds, streams, groundwater recharge areas, springs, wetlands and aquifers are managed to assure the sustainability of high quantity and quality water. Where new or re-authorized water extraction or diversion is allowed, those facilities should be located to avoid long-term adverse impacts to national forest water and riparian resources. The Forest Service has acquired and maintains water rights where necessary to support resource management and healthy forest conditions. Forest management activities are planned and implemented in a manner that minimizes the risk to forest ecosystems from hazardous materials.

Goal 5.2: Improve riparian conditions.

Riparian and aquatic ecosystems occur on all four southern California national forests and are associated with water. They play a vital role in watershed functioning and in the survival of most of the species-at-risk. These ecosystems contain aquatic and terrestrial features and lands adjacent to perennial, intermittent, and ephemeral streams, as well as in and around meadows, lakes, reservoirs, ponds, wetlands, vernal pools, seeps, springs and other bodies of water.

Riparian Conservation Areas (RCAs) are areas along streams and around water/riparian features that are identified to protect riparian and aquatic ecosystems and the dependent natural resources associated with them during site-specific project planning and implementation. Standard S47 (in Appendix E and Part 3) explain the concept and the process for delineating RCAs. A variety of national forest management activities occur within RCAs, both as planned activities and as emergency actions. Because these activities can disrupt riparian ecosystem processes and interactions that can result in adverse effects, RCAs serve to provide protection to these sensitive environments. Some of the greatest threats to riparian and aquatic habitats are from diversion of surface water, removal of shallow groundwater, the effects of prolonged drought conditions, and from the invasion of nonnative plant species, particularly tamarisk, arundo and cape ivy within the stream channels.

National Strategic Plan Goal 5- Improve watershed condition

Outcome: Increase the area of forest and grassland watersheds in fully functional and productive condition.

An estimated 3,400 towns and cities currently depend on National Forest System watersheds for their public water supplies. Our national forests and grasslands contain more than 3,000 public water supplies for campgrounds, administrative centers, and similar facilities. Communities that draw source water from national forests and grasslands provide water to 60 million people, or one-fourth of the nation's people. Although most forested watersheds are in fully functioning or satisfactory condition, many streams on National Forest System lands do not meet State water-quality standards. Some municipal watersheds, especially in the West, are at risk from catastrophic wildland fire and from impacts due to excessive use. These problems are compounded by land parcelization. The loss of valuable corridors connecting National Forest System land with other undisturbed tracts of land increases the difficulty of effectively managing watershed conditions. Sustaining functional watershed conditions over time maintains the productive capacity of our land and water.

The following objectives support this goal:

1. Objective: Assess and restore high-priority watersheds and maintain riparian habitat within these watersheds.
2. Objective: Monitor water quality impacts of activities on National Forest System lands.
3. Objective: Restore and maintain native and desired nonnative plant and animal species diversity within terrestrial and aquatic ecosystems and reduce the rate of species endangerment by contributing to species recovery.

Part 2 - San Bernardino National Forest Strategy

Land Management Plan Strategy

This document is Part 2 of the three-part (vision, strategy and design criteria) land and resource management plan (forest plan) for the San Bernardino National Forest. The strategic direction and program emphasis objectives that are expected to result in the sustainability (social, economic and ecological) of the national forest and, over the long-term, the maintenance of a healthy forest are described in this document. The legislative mandate for the management of national forests requires that public lands be conservatively used and managed in order to ensure their sustainability and to guarantee that future generations will continue to benefit from their many values. Forest plans are founded on the concept of sustainable use of the national forests. In its simplest terms, sustainability means to maintain or prolong. In order to foster the concept of sustainability, this section describes the program emphasis and strategies that may be employed to enable multiple uses to occur in ways that promote long-term sustainability. The program emphasis and management strategies are continuously projected over a three to five year period (over the life of the plan) in order to describe the projects or activities that may be employed as we move along the pathways toward the realization of the desired conditions described in Part 1 of the revised forest plan.

Physical Resources (Soil, Geology, Water and Air)

The San Bernardino National Forest was established to protect the watersheds that influence runoff and supply water to local communities and municipalities. Activities include management of lands and water quality, water supply, soil quality and productivity, and water rights. The Soil and Watershed Program cooperates with various water agencies and other national forest functional areas to reduce erosion and maintain high quality water for the various users and natural resources through application of Best Management Practices in all Forest Service activities (WAT 1 - Watershed Function). The program also involves restoration of damaged lands through soil and watershed improvement projects (WAT 2 - Water Management, and WAT 3 - Hazardous Materials). Maintaining public water rights on the national forest through the State Water Rights Process is another important activity (WAT 2 - Water Management).

The overall Physical Resources Program emphasis will be three fold: 1) support and help facilitate fuels and vegetation management efforts designed to maintain or restore watershed health and protect life and property (WAT 1 - Watershed Function); 2) repair soil and watershed degradation; and 3) provide burned area emergency rehabilitation treatments after wildland fires to reduce potential flood damage to downstream resources and communities (WAT 1 - Watershed Function).

Roads

This program area focuses on operating and maintaining the National Forest system roads within the San Bernardino National Forest. The national forest's National Forest System raods consists of 1,178 miles of dirt roads and 56 miles of paved roads. Other paved roads and dirt roads are maintained and operated by other entities, including Caltrans (state), counties, and the private sector. Maintenance activities include maintaining roadside vegetation, removing weeds, grading, paving, striping, repairing potholes, cleaning and installing drainage control structures, removal of rocks and landslides, repairing washouts, and bridge repairs. Roads are maintained to provide for user safety and to meet road maintenance management objectives. Operations for the Roads Program include managing road closures, restrictions, use permits, maintenance agreements, and rights-of-way use agreements.

The Roads Program will emphasize managing the transportation system to accommodate increased user demand, to reduce conflicts between user groups, to protect the national forest and communities, and other resource considerations. National Forest System roads and trails will be maintained to reduce the level of adverse effects to species and watersheds while safely accommodating use (see REC 3 - Recreation Participation). National Forest staff expect to maintain approximately 20 percent of the National Forest System roads to their objective operation maintenance level (see Trans 1 - Transportation Management).

Water

Local demand for water is greater than can be produced from national forest watersheds. Groundwater extraction from the national forest contributes to the municipal water supply for many urban communities within and adjacent to the national forest. The national forest produces a significant amount of the total water demand within its area of influence.

The Physical Resources Program emphasis is expected to balance the needs of water users with resource needs for maintaining or improving stream, riparian, springs and wetland habitat by procuring water rights and instream flow agreements to address the increased demand for the ground and surface water resources of the national forest (see

WAT 2 - Water Management). National Forest staff expect to complete approximately 5 percent of the water diversion permit reauthorizations backlog (see Lands 2 - Non-Recreation Special Use Authorizations), including acquiring available water rights or relocating diversions to the national forest perimeter where there is a demonstrated need for riparian species management.

Places

Bautista 5th Field Watershed = Anza Place

Theme: Chaparral-covered hillsides braided by seasonally flowing streams. Anza offers a distinctive, rural character, and remote open space, just miles from major urban centers. The Juan Bautista de Anza National Historic Trail marks the passage of early Spanish explorers through Bautista Canyon.

Settings: The Anza Place is located within the San Jacinto foothills, stretching from the valley communities of Hemet and San Jacinto to Cahuilla Mountain and the southwestern slope of Thomas Mountain. To the south lies the community of Anza, named after the Spanish explorer Juan Bautista De Anza, who led an overland expedition in this area in the 1770s. De Anza traveled through the heart of this landscape on his expedition from Tubac, Arizona north to San Francisco. Visitors often travel through Bautista Canyon revisiting this historic route, or as a short cut from Hemet to Anza. The Cahuilla Mountain Research Natural Area located here is dedicated to the study of Coulter pine and black oak. Portions of the active Rouse grazing allotment are present within this Place.

The climate is temperate, with sub-humid to hot summers at the lower elevations of 1,500 feet; giving way to cooler temperatures in the higher elevations. Most of this land is semi-arid with no lakes or man-made reservoirs, and all streams are dry in the summer except for springs fed from the higher mountains. Annual precipitation ranges from 10 to 30 inches per year, mostly in the form of rain. Steep mountains characterize the land, with narrow to rounded ridges and narrow canyons.

Traditionally, the Cahuilla Indians used these lands, and had extensive trade networks with neighboring tribes. Today, many areas within the Place continue to be used by the Cahuilla and their neighbors the Luiseno. Access to tribal collecting areas is adequate, but could be improved. In 1893, the reservation was established for the Ramona Band of Cahuilla Indians. The reservation is bordered by National Forest System land on three sides.

Grasslands in the valleys yield to a chaparral covered landscape at the lower elevations, including chamise, buckwheat, sage and mountain lilac. In the higher elevations, there are stands of canyon live oak, pine and bigcone Douglas-fir. Much of the landscape is dense chaparral on the slopes, with a riparian corridor along the Bautista Canyon bottom that contains diverse species of trees, shrubs, forbs, sedges, rushes and grasses. Wildland fire threat is ever-present here, along with the cycle of erosion and flood.

The southwestern willow flycatcher, the San Bernardino kangaroo rat, arroyo toad and Quino checkerspot butterfly occur within the Place. The biological diversity along the river corridors within this Place is unusually high. Critical habitat for San Bernardino kangaroo rat is designated close to the San Jacinto River. Bautista Creek possesses the largest number of endangered and Region 5 sensitive wildlife species of any location on the national forest. Designated critical habitat for San Bernardino kangaroo rat and proposed critical habitat for arroyo toad occurs in Bautista Canyon. Bautista Creek also supports the only population on the national forest of the endangered slender horned spine-flower. Alluvial fan scrub habitat is present. The encroachment of tamarisk (an invasive nonnative species within the creek corridor) reduces the water table and affects species diversity. There is critical habitat for the Quino checkerspot butterfly in the vicinity of Hixon Flat. Deer, quail, and mountain lions are present throughout the Anza Place. Private lands adjacent to the southern portion of the Place provide a regional habitat linkage connecting the San Jacinto Mountains to the Palomar Mountains on the Cleveland National Forest.

The Anza Place is sparsely populated, with most of the population located in the adjacent communities of Hemet, San Jacinto and the Anza Valley. No major highways transect this area, and there are only a few national forest dirt roads. Because of the limited access, the area is not a high-use recreation area. Most of the visitation focuses on hiking, biking, hunting and driving for pleasure. A designated OHV route system is present. Remote camping is available. Trash dumping and target shooting in unauthorized locations occurs frequently.

Desired Condition: The Anza Place is maintained as a historic and natural appearing landscape that functions as a transition zone to the higher mountains beyond, as well as providing a natural continuous expanse of vegetation as viewed from the High Country. The valued landscape attributes to be preserved over time are the mosaic pattern of the chaparral-covered hills, the ribbons of diverse native vegetation in the canyons and riparian areas, the presence of oaks, bigcone Douglas-fir and pine in higher elevations. Native American access to traditional gathering areas is improved and areas are protected. Heritage resource sites are protected. Active grazing allotments are sustainable and contain a high proportion of native species. Chaparral communities and timber stands are at pre-fire suppression conditions. Habitat conditions for threatened, endangered, proposed, candidate and sensitive species are improving over time. Tamarisk and other exotic species are reduced over time. Accurate national forest boundaries are reestablished and maintained.

Program Emphasis: Community protection from wildland fire is of the highest priority. It will be emphasized through public education, fire prevention, forest interpretation and fuels management. Forest health projects will be implemented to remove dead trees, reduce stand density, and promote pre-settlement fire return intervals. Reforestation projects will maintain tree diversity. Visitor experiences will be enhanced through interpretation of the historic route of Juan Bautista De Anza National Historic Trail. The improvement of the OHV route system will be explored, as will a motorized right-of-way access for fire suppression in Reed Valley. Enhancement of wildlife habitat for threatened, endangered, proposed, candidate and sensitive species, such as the southwestern willow flycatcher, arroyo toad, San Bernardino Kangaroo rat, Quino checkerspot butterfly, and slender horned spineflower will be emphasized in all management activities. Maintaining the unique biological diversity found in Bautista Creek and the San Jacinto River, removal of tamarisk and other exotic species, and management of the national forest portion of the regional habitat linkage to the south will also be emphasized. Heritage resource sites and Native American gathering areas will be protected. Native American tribes will become partners through protocol agreements and provide assistance with interpretation and management of traditional gathering areas. The California Site Steward Program will be implemented. Accurate national forest boundaries along the Wildland/Urban Interface will be reestablished and maintained. Law enforcement actions and activities will be emphasized to eliminate unauthorized shooting and trash dumping in streamside areas and to promote public and employee safety.

Garner 5th Field Watershed = Garner Valley Place

Theme: Green meadows and historic ranchland in an expansive mountain valley frame the Garner Valley Place. Lake Hemet and surrounding areas offer popular recreation opportunities and scenic vistas of an open pine forest.

Setting: Garner Valley Place is located within the San Jacinto Mountain Range. The San Jacinto Wilderness borders the Place to the north, while the Santa Rosa and San Jacinto Mountains National Monument forms its eastern boundary. California State Highway 74 (the Palms to Pines Scenic Byway) traverses this area from southeast to northwest. Garner Valley offers access and views into the San Jacinto Wilderness.

Elevations within the Garner Valley Place range from approximately 2,500 feet to over 8,500 feet. Historically, the area has been mined and grazed; grazing continues today. The Paradise and Garner Grazing Allotments are active. Portions of the Rouse and Wellman Grazing Allotments are also active.

The mountain climate ranges from hot to temperate in the lower elevations and cold temperatures in the higher elevations. Annual precipitation varies from 16 to 30 inches, with snow falling mostly in the higher elevations. Water is scarce in the summer months, except for scattered springs and groundwater. Lake Hemet is the largest body of water in the area. It is an artificial reservoir providing water to the local area, and boating and fishing opportunities. Striking rock outcrops and unique landforms are found along the desert divide, which forms the boundary with the Santa Rosa and San Jacinto Mountains National Monument.

The Garner Valley Place is blanketed with basin sagebrush intermingled with meadow plants and nonnative grasses. Jeffrey pine grows along the valley's edge, while at the south end pinyon/juniper woodlands prevail. Ponderosa pine stands and mixed conifer forest are found on the slopes of Mt. San Jacinto, with lodgepole pine present at higher elevations. Parry pinyon and red shank chaparral are also present. Sagebrush encroachment is occurring in the valley and its adjacent timbered areas as a result of past fire suppression activities. Because sagebrush is highly flammable, the risk that fires will destroy the trees and convert the area to brush and grassland is high. Dense chaparral stands in timbered areas also threaten conifer vegetation. Substantial conifer mortality has created a fuel buildup that is a problem for community protection.

The large acreages of montane meadow found here provide habitat for many unique plants and animals. The foothills above the valley support pebble plain-like habitat unique to the San Jacinto Mountains. The only known locations of Johnson's rock cress, a Region 5 sensitive plant species, are found in this Place. One of the only locations on southern California where bald eagles can be observed year-round is found at Lake Hemet. The highest known distribution for Quino checkerspot butterfly is found in the southeastern portion of the valley. Garner Valley meadows and adjacent uplands are important deer habitat where fire has been used to maintain habitat quality. A State Game Refuge located at the northern end of the valley provides protection for game species from hunting. The Cahuilla Indians were the earliest known people living in Garner Valley and it is believed that their ancestors settled in the Place thousands of years ago.

The Cahuillas' lived here for hundreds of years prior to European settlement and they continue traditional use of the land today. The Santa Rosa Band of Mission Indians' Reservation is located on the southeastern side of the Place. Historic Euro-American land uses of the Place include ranching, some mining, and later, recreation uses of Lake Hemet and local trails. Early ranchers cleared the pine-covered Garner Valley to create pastures for their cattle and horses.

Access to the national forest is a concern in Garner Valley, as the Forest Service does not hold public rights-of-way and private landowners allow limited access through their property. The proximity of local communities to national forest land has also led to numerous encroachments in the area.

This Place contains a variety of recreation opportunities, including mountain biking, hiking, hunting, fishing, camping, and equestrian use. Opportunities for primitive recreation are present in the San Jacinto Wilderness. Tool Box Spring Campground and Lake Hemet Picnic Area are located here, and the Pacific Crest Trail traverses the eastern boundary of the area along the desert divide. There is insufficient parking at some trailheads to accommodate users and conflicts occasionally arise among some hiking, biking, and equestrian trail users.

Desired Condition: Garner Valley Place is maintained as a historic and natural appearing landscape that functions as a recreation setting offering scenic vistas of open pine forests. The valued landscape attributes to be preserved over time are the natural appearing landscape views from the Scenic Byway, the presence of montane meadows, the Jeffrey pine forests along the valley's edge, the mixed conifer forests and bigcone Douglas-fir stands, and lodgepole pine in higher elevations. Heritage resources are managed to standard. Active grazing allotments are sustainable and contain a high proportion of native species. Chaparral communities and timber stands are at pre-fire suppression conditions. Habitat conditions for threatened, endangered, proposed, candidate and sensitive species are improving over time. Accurate national forest boundaries are reestablished and maintained. Rights-of-way to improve public access to national forest land are acquired.

Program Emphasis: Community protection from wildland fire is of the highest priority. It will be emphasized through public education, fire prevention, fuels management and direct suppression. Community protection projects identified in the San Jacinto Wilderness may be implemented to reduce the risk of wildland fire to communities. Forest health projects will be implemented to remove dead trees, reduce stand density, promote pre-fire suppression fire return intervals and reduce sagebrush encroachment. Reforestation projects will maintain tree diversity.

Management will focus on maintaining the open grassland character and expansive wet meadows and vistas of Garner Valley. Allotment management will be emphasized. Wherever possible, acquisition of land will be emphasized to improve public and administrative access, protect resources, and maintain open space and scenic qualities. Accurate national forest boundaries along the urban interface will be reestablished and maintained. Developed recreation sites will be improved and new recreation opportunities will be explored. Heritage resources will be protected and interpreted as appropriate. Enhancement of wildlife habitat for threatened, endangered, proposed, candidate, and sensitive species, such as bald eagles, Quino checkerspot butterfly and unique plant species will be emphasized in all management activities.

Upper San Jacinto 5th Field Watershed = Idyllwild Place

Theme: A mountain hideaway of art and music nestled beneath jagged rocks and towering pines, Idyllwild is the gateway to the San Jacinto Wilderness.

Setting: The Idyllwild Place is located in the higher elevations of the San Jacinto Mountains and is characterized by steep canyons and jagged rocks. Elevations in the Place range from 2,000 feet to 10,804 feet at the top of San Jacinto peak. The San Jacinto Wilderness has long been a popular destination for visitors to this Place, and the newly created Santa Rosa and San Jacinto Mountains National Monument borders the eastern boundary. The spectacular features of the national forest provide the backdrop for this unique community. Idyllwild attracts and inspires many people interested in the arts. Because of its proximity to Palm Springs, this Place continues to receive a large number of international visitors. The Hall Canyon Research Natural Area, dedicated to the study of mixed conifer forest, and the Black Mountain Scenic Area are located here, as is Mt. San Jacinto State Park.

The mountain climate ranges from hot to temperate at the lower elevations and cold temperatures at the highest elevations. Surface water is scarce in the summer months, except for scattered springs and the perennial streams of the North Fork of the San Jacinto River and Fuller Mill Creek. Lake Fulmor, a small man-made lake, is located here as is Baytree Springs, an important drinking water gathering area for locals and visitors alike. Annual precipitation ranges from 16 to 30 inches, with snow falling mostly at the highest elevations.

The San Jacinto foothills contain a mix of manzanita, sagebrush, buckwheat, chamise and scrub oak. In the higher elevations, the chaparral gives way to stands of bigcone Douglas-fir, mixed oak and conifer, including California black oak and canyon live oak. Coulter pine, sugar pine, Jeffrey Pine, ponderosa pine, incense cedar, white fir and lodgepole pine are also present. The Vista Grande and Soboba Grazing Allotments are currently vacant.

Many private inholdings are located within or adjacent to National Forest System lands in this Place. Fuel buildup has occurred in the chaparral and timbered portions of this Place, increasing the probability of large stand replacement fires. Fire hazard has been exacerbated by drought and a high level of tree mortality, presenting risks to private landowners and national forest facilities. Wildland/Urban Interface Defense and Threat Zones are needed to protect Idyllwild and surrounding communities. Use of prescribed fire is also needed.

This popular mountain Place contains unique biological diversity. A distinct population of mountain yellow-legged frog occurs here. California spotted owls are present. Southern rubber boas occur here at the southernmost portion of their range. San Bernardino flying squirrels are also known to have occurred here. A small amount of critical habitat for the San Bernardino kangaroo rat, and the arroyo toad is present along the San Jacinto River. A small amount of critical habitat for the Peninsular Range bighorn sheep is also present. The only known occurrences of the California bedstraw, a Region 5 sensitive plant species, occur here; lemon lilies are also present. The northern portion of this Place is an important element of the regional habitat linkage connecting the San Jacinto Mountains and the San Bernardino Mountain Front Country through the Banning Pass.

California State Highway 243 (entering the national forest from the north at Banning) runs southeast as the Palms to Pines Scenic Byway. This is a highly traveled scenic route where people can spend the day driving for pleasure. Access to National Forest System land within this Place is generally good, although some areas near the community of Idyllwild are lacking rights-of-way due to the large number of private in-holdings. The proximity of the communities to the national forest has led to numerous encroachments.

The Idyllwild Place was inhabited hundreds of years ago by the Cahuilla Indians and their ancestors. The Serrano and Luiseno Indians also traveled through, and possibly settled in this Place. Numerous trade routes traversed through this Place. The Morongo Band of Mission Indians' Reservation lies immediately north of the Place. Members of the Ramona Band of Cahuilla Indians, Santa Rosa Band of Mission Indians, the Soboba

Band of Luiseno Indians, the Cahuilla Band of Mission Indians, and the Agua Caliente Band of Cahuilla Indians still have ties to the Place today. Settlers of European descent traveled to the Place in the late 1860s to log, mine, raise cattle and create a retreat. During the Great Depression, the Civilian Conservation Corp constructed Black Mountain Road, Tahquitz Peak Lookout, along with guard stations, trails, campgrounds and fuelbreaks.

National Forest visitors find opportunities to hike, camp, fish, horseback ride and mountain bike, while rock climbers try their skills at climbing vertical faces of rock. Opportunities for primitive recreation are present in the San Jacinto Wilderness. Information on recreation opportunities is available at the newly renovated Idyllwild District Office. There is a high demand for snowplay here during the winter months. Bee Canyon is heavily used for recreational target shooting, and hunters find a variety of game in the more remote areas. The Pacific Crest Trail traverses through Idyllwild Place within the San Jacinto Wilderness. A non-motorized trail linking Idyllwild to Pine Cove on the national forest has been proposed with community support. A limited number of "easy" hiking trails can be accessed from Idyllwild Place. Opportunities for both mountain bike and off-highway vehicle use are limited. There is a designated OHV route system in the Angeles Hill/Indian Mountain area. Developed recreation facilities are in need of renovation.

Law enforcement staffing levels are inadequate to manage the number of users. Activities, such as trash dumping, unlawful off-road vehicle use, and property vandalism are reoccurring problems. Unlawful activities, such marijuana cultivation, methamphetamine lab dumps, and abandonment of stolen vehicles are increasing as the urban areas adjacent to the national forest are being developed. Protection of the numerous heritage resources located within the area is also a concern. Conflicts between recreational target shooters and OHV use are reoccurring problems in Bee Canyon.

Desired Condition: Idyllwild Place is maintained as a natural appearing landscape that functions as a recreation setting and wilderness gateway. The valued landscape attributes to be preserved over time are the natural appearing views from the scenic byway and Pacific Crest Trail, the presence of conifers above the 4,000-foot level, the current diversity of chaparral species at the foothill locations, and the presence of rock outcrops. Chaparral communities and timber stands are at pre-fire suppression conditions. Heritage resources are identified, protected and interpreted as appropriate. Traditional cultural properties are protected. Habitat conditions for threatened, endangered, proposed, candidate and sensitive species are improving over time. Accurate national forest boundaries are reestablished and maintained. A wide variety of dispersed and developed opportunities are maintained and improved.

Program Emphasis: Community protection from wildland fire is of the highest priority. It will be emphasized through public education, fire prevention, and fuels management. Community protection projects identified in the San Jacinto Wilderness may be implemented to reduce the risk of wildland fire to communities. Forest health projects will be implemented to remove dead trees, reduce stand density, and promote pre-fire suppression fire return intervals. Reforestation projects will maintain tree diversity.

Conservation education, with a focus on the demonstration and interpretation of healthy forests, at the expanded District Office will be emphasized to enhance the experience of visitors and promote stewardship.

The scenic focus will be on maintaining views of jagged rocks and towering pines, especially from the scenic byway. Wherever possible, acquisition of land will be emphasized to improve public and administrative access and to maintain open space and scenic qualities. Accurate national forest boundaries along the urban interface will be reestablished and maintained. Trespass and encroachment will be reduced. Opportunities for a variety of new non-motorized trails (especially short, easy-to-moderate difficulty, day loop trails) and designated recreational target shooting and snowplay areas will be explored. Developed recreation sites will be improved. The Pacific Crest National Scenic Trail remains a priority for management and maintenance. The OHV route system in the Angeles Hill-Indian Mountain area is evaluated for needed improvement. Unauthorized OHV use is directed to designated routes. Law enforcement activities will be coordinated with other functional areas for the protection of national forest resources and the safety of national forest visitors and employees.

Enhancement of habitat for threatened, endangered, proposed, candidate and sensitive species, such as the mountain yellow-legged frog, California spotted owl, southern rubber boa and California bedstraw will be emphasized in all management activities. Surveys will be conducted to determine continued presence of San Bernardino flying squirrel. Activities will also be managed to maintain the regional habitat linkages to the north and west. Significant heritage sites will be protected and enhanced. Heritage resource sites and Watchable Wildlife areas will be managed and interpreted along travel corridors within the Place.

Forest-specific Design Criteria

WAT 1 - Watershed Function

Protect, maintain and restore natural watershed functions including slope processes, surface water and groundwater flow and retention, and riparian area sustainability:

- Assess the impacts of existing or proposed groundwater extraction and tunneling projects and proposals in order to assure that developments will not adversely affect aquatic, riparian or upland ecosystems.

- Restore, maintain and improve watershed conditions over the long-term. Assure that approved and funded rehabilitation and emergency watershed treatments are implemented in an effective and timely manner.

- Maintain or restore soil properties and productivity to ensure ecosystem health (soil microbiota and vegetation growth), soil hydrologic function, and biological buffering capacity.

- Manage Riparian Conservation Areas (RCAs) to maintain or improve conditions for riparian dependent resources. Riparian conservation areas include aquatic and terrestrial ecosystems and lands adjacent to perennial and intermittent streams, as well as around meadows, lakes, reservoirs, ponds, wetlands, seeps, and springs and other water bodies. Riparian dependent resources are those natural resources that owe their existence to the area, such as fish, amphibians, reptiles, fairy shrimp, aquatic invertebrates, plants, birds, mammals, soil and water quality.
- Achieve and maintain natural stream channel conductivity, connectivity and function.
- Assess and manage geologic resources and hazards to integrate earth science principals and relationships into ecosystem management; reduce risks to people and resources; and interpret and protect unique values.
- Identify and prioritize based on risk, and mitigate impacts of abandoned and inactive landfills on water, soil and other resources. Stabilize and, where necessary, reclaim abandoned and inactive landfills to maintain proper watershed function, public safety and resource benefit.
- Inventory, analyze and prioritize abandoned mines to identify chemical and physical hazards, historic significance, and biological resources prior to reclamation. Mitigate safety hazards and adverse environmental impacts, conduct reclamation as needed, and assure that water quality standards are met.
- Maintain watershed integrity by replacing or disposing of displaced soil and rock debris in approved placement sites.
- Develop direction and policy (southern California, national forest, or place-wide as appropriate) for protecting, collecting, curating, and distributing paleontologic resources.

WAT 2 - Water Management

Manage groundwater and surface water to maintain or improve water quantity and quality in ways that minimize adverse effects over the long-term:

- Assess impacts of existing and proposed groundwater extractions and tunneling projects and proposals to assure that developments will not adversely affect aquatic, riparian or upland ecosystems and other uses, resources or rights (e.g., tribal water rights).
- Promote water conservation at all national forest administrative and authorized facilities.
- Protect and improve water quality by implementing best management practices and other project-specific water quality protection measures for all national forest and authorized activities. Include appropriate conservation and water quality mitigation measures in the review response when reviewing non-forest water-related projects that may affect forest resources.
- Conserve and protect high-quality water sources in quantities adequate to meet national forest needs.
- Take appropriate actions to meet Total Maximum Daily Load (TMDL) standards.

- Take corrective actions to eliminate the conditions leading to State listing of 303(d)-impaired waters on National Forest System land. For those waters that are both on and off National Forest System land, ensure that Forest Service management does not contribute to listed water quality degradation.
- Actively pursue water rights and water allocation processes to secure instream flows and groundwater resources for current and future needs sufficient to sustain native riparian dependent resources and other national forest resources and uses.
- Identify the need for and encourage the establishment of water releases, for current and future use, to maintain instream flow needs including channel maintenance, and to protect and eliminate impacts on riparian dependent resources.
- Participate in all Federal Energy Regulatory Commission licensing and re-licensing efforts on National Forest System land to ensure sufficient consideration and protection is provided for riparian dependent resources. Incorporate instream flow, riparian, and other natural resource management requirements into 4(e) license conditions.
- Monitor water development projects to ensure that instream flows are meeting riparian dependent resource needs.
- To maintain or improve habitat containing threatened, endangered, proposed, candidate, and sensitive species coordinate activities with CDF&G, NOAA Fisheries, USFWS, State Water Resource Control Board and other appropriate agencies involved in recommending instream flow and surface water requirements for waterways.
- Cooperate with federal, tribal, state and local governments and private entities to secure the instream flow needed to maintain, recover, and restore riparian dependent resources, channel conditions and aquatic habitat.

LG 1 - Livestock Grazing

Livestock grazing areas are maintained and remain sustainable and suitable over the long-term.

- Administer each livestock grazing area to standard within a three-year period. Administering a livestock grazing area to standard includes: ensuring compliance with terms and conditions of the permit, allotment management plans, annual operating instructions, biological opinions, and forest plan standards. Permittees monitor for compliance with the permit standards and guides. The permittee submits monitoring and allotment management reports to the national forest officer in charge when requested (FSH 2209.13, 15.14b).

LG 2 - Rangeland Health

Rangelands are healthy and sustainable over the long-term. Rangelands are meeting or moving toward forest plan, ecosystem, and site-specific desired conditions.

Evaluate ecosystem health every five years. Indicators used in the evaluation include, but are not limited to: measures of riparian structure and function; the amount and distribution of noxious weeds and invasive non-native species; soil health; threatened, endangered, proposed, candidate, and sensitive species habitat; rare plant species vigor;

plant community composition and structure; sensitive heritage resources; and water quality. Adjust livestock management as necessary.

Implement Best Management Practices for Water Quality.

Part 3 Design Criteria for the Southern California National Forest

Part 3 is the design criteria or 'the rules' that managers will operate with as we work toward the realization of the desired conditions described in Part 1 (Vision).

The Forest Service's intent is to use these standards in combination with other guidance that will be identified based on project analysis and planning. Other guidance means using information specific to the various resources that is described in Forest Service Manuals and Handbooks, Best Management Practices (BMPs), the Built Image Guide, Species Accounts, Soil and Water Conservation Handbooks, and more.

Part 3 of the Land Management Plan requires annual implementation monitoring of 10 percent of projects and ongoing activity sites.

S35: Manage dispersed recreation activities to ensure that environmental sustainability is maintained by utilizing the following measures:
• Discourage camping within 100 feet of sensitive resources and habitats, including meadows and bodies of water (springs, streams, ponds and lakes), or within 1/4 mile of developed recreation facilities.
• Discourage camping within 600 feet of any wildlife water source developments, such as guzzlers and water holes, in accordance with state laws.
* Motorized and non-motorized vehicle travel is restricted to National Forest System roads and trails and limited areas that are designated for vehicle use.

S38: Avoid establishment of staging areas, helibases, base camps, firelines or other areas of human concentration and equipment use within threatened, endangered and proposed species suitable and occupied habitats and riparian areas to the maximum extent possible when suppression of wildland fire and human safety are not compromised.

S46: Surface water diversions and groundwater extractions, including wells and spring developments will only be authorized when it is demonstrated by the user, and/or agreed to by the Forest Service, that the water extracted is excess to the current and reasonably foreseeable future needs of forest resources.
• Consideration of beneficial uses, existing water rights, and the absence of other available water sources will be part of the water extraction application.
• Approved extractions and diversions will provide for long-term protection and reasonable use of surface water and groundwater resources.
• Feasibility and sustainability assessments should be appropriately scaled to the magnitude of the extraction or diversion proposed.

S50: Mitigate negative long-term impacts from recreation use to soil, watershed, riparian or heritage resources (refer to Appendix D - Adaptive Mitigation for Recreation Uses).

When Implementing Livestock Grazing Activities
S51: Allotment specific review of rangeland capability and suitability guidelines (Appendix J - Livestock Capability and Suitability Guidelines) shall occur as part of a site-specific allotment or livestock grazing area level National Environmental Policy Act (NEPA) analysis. Permits will not be issued for livestock grazing areas determined to be not suitable or have insufficient grazing areas for sustaining a livestock operation.

S52: Soil Cover: Maintain an effective soil cover of 60 percent to provide for soil protection, water infiltration, and reduce the risk of accelerated soil erosion within designated livestock grazing areas. Soil cover includes: living vegetation (grasses, forbs, and prostrate plants); plant litter; and surface rock fragments greater than 3/4 inch.

Land Management Plan Monitoring

Effective Land Management Plan (LMP) monitoring and evaluation fosters improved management and more informed planning decisions. It helps identify the need to adjust desired conditions, goals, objectives, standards and guidelines as conditions change. Monitoring and evaluation helps forests, grasslands, the Agency and the public determine how a LMP is being implemented, whether plan implementation is achieving desired outcomes, and whether assumptions made in the planning process are valid.

Monitoring and evaluation are learning tools that form the backbone of adaptive management. With these tools, information is collected and compiled to serve as reference points for the future; new scientific understanding and technology, changes in law and policy and resource conditions, growing concerns, trends and changing societal values are incorporated into forest/grassland planning; and the scientific validity and appropriateness of assumptions used in the development of forest/grassland plans is evaluated. In short, they breathe life into a static document—the LMP—to make it dynamic, relevant and useful.

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Attachment C.

Lake Elsinore Sediment Nutrient Reduction Plan

Lake Elsinore & San Jacinto Watersheds Authority

City of Lake Elsinore • City of Canyon Lake • County of Riverside
Elsinore Valley Municipal Water District • Santa Ana Watershed Project Authority

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October 31, 2007

Hope Smythe
Regional Water Quality Control Board
3737 Main St., Suite 500
Riverside, CA 92501

RE: Lake Elsinore and Canyon Lake Nutrient TMDL Task Deliverable
Task 9 – Lake Elsinore In-lake Sediment Nutrient Reduction Plan

Dear Ms. Smythe:

Enclosed is the Lake Elsinore In-lake Sediment Nutrient Reduction Plan, submitted by LESJWA on behalf of the Lake Elsinore and Canyon Lake nutrient TMDL Task Force. This plan addresses the requirements of Task 9 of the Lake Elsinore and Canyon Lake Nutrient TMDL.

Thank you for your consideration. If you have any questions or concerns regarding this report, please contact me at 951-354-4221.

Respectfully submitted,

Mark Norton

Mark Norton P.E.
LE/CL TMDL Task Force Administrator

Enclosure

1. Lake Elsinore In-lake Sediment Nutrient Reduction Plan

In-Lake Sediment Nutrient Reduction Plan

for

Lake Elsinore

Submitted to:

California Regional Water Quality Control Board – Santa Ana Region

Submitted by:

Lake Elsinore/Canyon Lake TMDL Task Force

October 31, 2007

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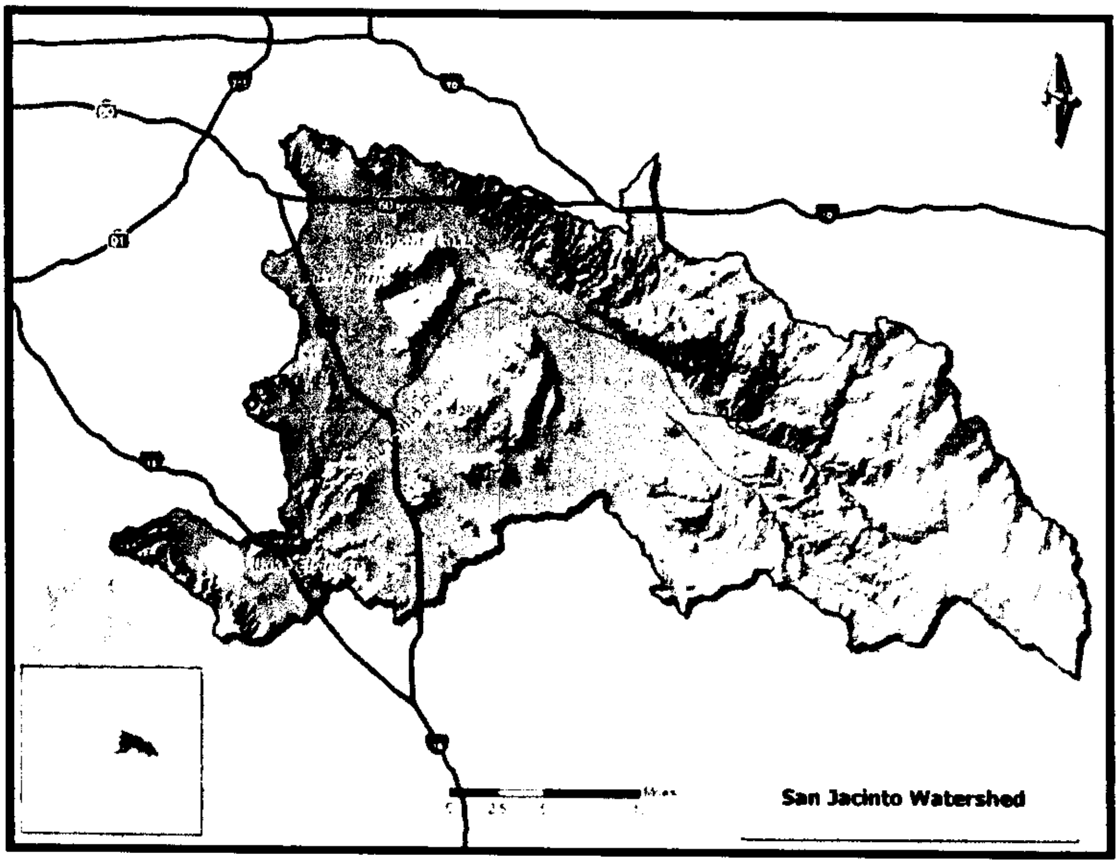
1.0 Background

Lake Elsinore is located approximately 60 miles southeast of downtown Los Angeles (see Fig. A). It has a surface area of approximately 3,000 acres and a mean depth of approximately 13 ft. The lake provides aquatic habitat for a variety of freshwater species and recreational opportunities for a large number of people living throughout southern California.

Figure A: Lake Elsinore in Riverside County, California



In 1998, the Santa Ana Regional Water Quality Control Board added Lake Elsinore to the 303(d) list of impaired water bodies because it is eutrophic. Excessive algal blooms and low dissolved oxygen levels are caused by elevated nutrient (e.g. nitrogen and phosphorus) concentrations in the water column. These conditions, in turn, cause recurring fish kills and other noxious conditions in the lake.

For several years, the Regional Board worked closely with stakeholders to identify and quantify all natural and anthropogenic sources of nutrients in the watershed. In 2004, the Regional Board relied on results from these on-going investigations to adopt a Total Maximum Daily Load (TMDL) to control nitrogen and phosphorus concentrations in Lake Elsinore.[1] The TMDL was subsequently approved by the State Water Resources Control Board[2] and by the U.S. Environmental Protection Agency.[3]

The TMDL Implementation Plan enacted by the state and federal regulatory authorities requires point and non-point dischargers in the watershed to develop and submit an "In-Lake Sediment Nutrient Reduction Plan" for Lake Elsinore.[4] The purpose of the plan is to describe a long-term strategy to control nutrients released from in-lake sediments.

2.0 Goals and Outcomes

The foremost goal of the TMDL process is to protect the designated beneficial uses of Lake Elsinore. Therefore, the intended outcome is to achieve the level of water quality needed to support warm water aquatic habitat and recreational activities; at a minimum, this includes preventing excessive algae growth, dissolved oxygen depletion and fish kills in the lake. The Regional Board set forth specific indicators by which to measure successful implementation of the TMDL (see Table 1).

Table 1: Biological and Physical Indicators for Lake Elsinore[5]

Indicator	Interim Target *(by 2015)*	Final Target *(by 2020)*
Chlorophyll-a (algae)	Summer average no greater than 40 ug/L	Summer average no greater than 25 mg/L
Dissolved Oxygen	Depth average no less than 5 mg/L across all depths	No less than 5 mg/L at one meter above the lake bottom

[1] California Regional Water Quality Control Board #8 - Santa Ana Region; Resolution No. R8-2004-0037 (Dec. 20, 2004).
[2] California State Water Resources Control Board; Resolution No. 2005-0038 (May 19, 2005).
[3] U.S. EPA Approval Letter dated September 30, 2005
[4] The Lake Elsinore In-Lake Nutrient Reduction Plan is identified as Task #9 in Table 5-9s on page 7 of 21 of the TMDL (Resolution No. R8-2004-0037).
[5] Source: Table 5-9n on page 2 of 21 of Resolution No. R8-2004-0037.

It is expected that if the targets for dissolved oxygen and Chlorophyll-a can be met, then the fish kills and other aesthetic impairments to recreational uses will be virtually eliminated. It is also assumed that nutrient concentrations in the water column must be significantly reduced in order to achieve the desired outcome. Therefore, the Regional Board also adopted numeric targets for certain chemical concentrations in Lake Elsinore (see Table 2). These chemical targets were intended to ensure compliance with the Basin Plan's narrative water quality objectives that prohibit the discharge of substances that cause excessive algae growth or other nuisance conditions.[6]

Table 2: Water Chemistry Indicators for Lake Elsinore[7]

Indicator	Final Target Concentration *(by 2020)*
Total Phosphorus	Annual average no greater than 0.10 mg/L
Total Nitrogen	Annual average no greater than 0.75 mg/L
Ammonia-Nitrogen	Equation-based on Temperature & pH

In order to meet the physical, chemical and biological target values established in the TMDL, the Regional Board supported development of water quality models to estimate the assimilative capacity for nitrogen and phosphorus in Lake Elsinore.[8] These models, developed by Tetra Tech, Inc. and Dr. Michael Anderson, were used to establish load allocations for non-point sources and wasteload allocations for point sources (see Table 3).

Table 3: TMDL Allocations for Lake Elsinore[9]

	Phosphorus	Nitrogen
Current Loading	64,923 kg/yr	345,689 kg/yr
Allowed Loading	28,584 kg/yr	239,025 kg/yr
Net Excess Load	36,339 kg/yr	106,664 kg/yr
Required Reduction	56%	31%

Note: all source allocations are expressed as 10-year running averages.

[6] Regional Water Quality Control Board - Santa Ana Region. Water Quality Control Plan - Santa Ana River Basin (8). Resolution No. R8-1994-0001 (March 11, 1994). See page 4-5.
[7] Source: Table 5-9n on page 2 of 21 of Resolution No. R8-2004-0037.
[8] TetraTech Inc. Lake Elsinore and Canyon Lake Nutrient Source Assessment. 2003.
[9] Source: Table 5-9n on page 2 of 21 of Resolution No. R8-2004-0037.

The Santa Ana Regional Water Quality Control Board recognized that many different sources were contributing nutrient loads to Lake Elsinore. Consequently, maximum average loads were specified, by source, within the TMDL for both nitrogen (see Table 4) and phosphorus (see Table 5).[10] However, the TMDL does not require reductions in nitrogen loads from in-lake sediments because the Regional Board staff lacked sufficient data to calculate appropriate load allocations and wasteload allocations for nitrogen.[11] Additional studies are underway because control of nitrogen releases from sediment is likely to be important in order to ensure un-ionized ammonia toxicity does not cause or contribute to fish kills in the future. These studies are discussed in Section 4.3 of this Plan.

Table 4: Source Allocations for Nitrogen in Lake Elsinore

Source	Current Load	Allowed Load	Net Difference	Pct. Reduction
Internal Sediment	197,370 kg/yr	197,370 kg/yr	0 kg/yr	0%
Atmospheric Deposition	11,702 kg/yr	11,702 kg/yr	0 kg/yr	0%
Supplemental Water	59,532 kg/yr	7,442 kg/yr	52,090 kg/yr	87%
Septic Systems	1,058 kg/yr	608 kg/yr	450 kg/yr	43%
Urban Runoff	606 kg/yr	349 kg/yr	257 kg/yr	42%
Open or Forest Land	567 kg/yr	567 kg/yr	0 kg/yr	0%
Agriculture	371 kg/yr	213 kg/yr	158 kg/yr	43%
Outflow from Canyon Lake	25,547 kg/yr	20,774 kg/yr	4,773 kg/yr	19%
Total	**296,753 kg/yr**	**239,025 kg/yr**	**57,528 kg/yr**	**19%**

Table 5: Source Allocations for Phosphorus in Lake Elsinore

Source	Current Load	Allowed Load	Net Difference	Pct. Reduction
Internal Sediment	33,160 kg/yr	21,554 kg/yr	11,606 kg/yr	35%
Supplemental Water	14,883 kg/yr	3,721 kg/yr	11,162 kg/yr	75%
Open or Forest Land	178 kg/yr	178 kg/yr	0 kg/yr	0%
Urban Runoff	124 kg/yr	124 kg/yr	0 kg/yr	0%
Atmospheric Deposition	108 kg/yr	108 kg/yr	0 kg/yr	0%
Septic Systems	69 kg/yr	69 kg/yr	0 kg/yr	0%
Agriculture	60 kg/yr	60 kg/yr	0 kg/yr	0%
Outflow from Canyon Lake	7,294 kg/yr	2,770 kg/yr	4,524 kg/yr	62%
Total	**55,876 kg/yr**	**28,584 kg/yr**	**27,292 kg/yr**	**49%**

[10] Source: Table 5-9r on page 5 of 21 in Resolution No. R8-2004-0037. Note: allocations for internal sediment, supplemental water, open/forest land, urban runoff, atmospheric deposition, septic systems and agriculture refer only to the watershed area that drains directly to Lake Elsinore. Separate source allocations exist for these land-use types where they flow to Lake Elsinore, indirectly, through Canyon Lake.

[11] California Regional Water Quality Control Board - Santa Ana Region. Lake Elsinore and Canyon Lake Nutrient TMDL Technical Report, 2004, pg. 74.

In order to restore the nutrient balance in Lake Elsinore, it will be necessary to reduce total phosphorus loads by nearly 23,000 kg/yr. Reductions of such magnitude can only be achieved by controlling contributions from the three largest sources of phosphorus: in-lake sediment releases, reclaimed water discharges and in-flows from Canyon Lake. Remediation strategies aimed at controlling the latter two sources are governed by Elsinore Valley MWD's NPDES permit and other nutrient management plans specified in the Implementation Section of the TMDL (see Table 6).

Table 6: Nutrient Management Plans for External Sources to Lake Elsinore

Source	TMDL	Description	Due Date	Status
Agriculture	Task #5	Agricultural Discharges - Nutrient Management Plan	Sept. 30, 2007	☐
Septic Systems	Task #6	On-site Disposal Systems - Management Plan	Dependent on St. Bd. approval of relevant regulations	☐
Urban Runoff	Task #7	Revision of Drainage Area Mngt. Plan (DAMP) and Water Quality Management Plan (WQMP)	Aug. 1, 2006	☑
Forest Lands	Task #8	Forest Area Review/Revision of Forest Service Management Plans	Sept. 30, 2007	☐
Canyon Lake Pass-Thru	Task #10	Canyon Lake In-Lake Sediment Treatment Evaluation	May 31, 2007	☑

Most external nutrient loads are transported to the lake in the very wettest (aka "El Niño") years (see Table 7). Sustained heavy rains, like as those that occurred in 1993 and 1995, occur less than 17% of the time but contribute nearly three-quarters of all new phosphorus loads to Lake Elsinore. During the dry and moderate weather conditions that normally predominate in the region, the vast majority of the San Jacinto watershed contributes virtually no flow or nutrient loads to Lake Elsinore.[12] Rather, during dry and moderate years, most stormwater runoff is retained in Mystic Lake and/or Canyon Lake before it reaches Lake Elsinore.

Given the immense flows that occur during El Niño, sometimes exceeding 500 cfs in the San Jacinto River channel, it is technically infeasible to divert the stormwater runoff.[13] In addition, even if all external nutrient loads were eliminated entirely, water quality conditions in Lake Elsinore would likely remain impaired for many decades, perhaps centuries.[14] Nevertheless, the TMDL requires external loads to be reduced or offset in order to comply with relevant nutrient targets and related water quality objectives.

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[12] Tetra Tech, Inc.; Lake Elsinore and Canyon Lake Nutrient Source Assessment Final Report. January, 2003; see Tables 5-5 thru 5-13 on pgs. 5-8 thru 5-12.

[13] Riverside County Flood Control and Water Conservation District. Canyon Lake, Lake Elsinore and San Jacinto River Watershed Tour. Handout Packet dated Nov. 30, 2004.

[14] MWH. Final Report: Engineering and Feasibility Study for NPDES Permit for Discharge to Lake Elsinore. Feb., 2002. See pg. 4-4.

Nutrient cycling from bottom sediments is now the dominant factor driving ambient water quality conditions in the lake.[15] Therefore, the most practical approach is to mitigate the adverse effects of phosphorus after it reaches the lake but before it can impair the beneficial uses. However, if this "offset approach" proves unsuccessful at meeting water quality objectives in Lake Elsinore, additional controls to reduce external loads more directly may become necessary to comply with the TMDL.

Table 7: Estimated External Phosphorus Loads to Lake Elsinore (1993 – 2004)[16]

Rank	Year	External Load	Percent of 12-yr. Load	Cumulative Percent	TMDL Category
1	1993	99,487 kg	59%	59%	Wet
2	1995	22,257 kg	13%	72%	Wet
3	2004	9,897 kg	6%	78%	Moderate
4	1998	9,107 kg	5%	83%	Moderate
5	2003	8,593 kg	5%	88%	Moderate
6	2002	4,339 kg	3%	91%	Moderate
7	1997	3,816 kg	2%	93%	Moderate
8	1994	2,948 kg	2%	95%	Dry
9	1996	2,455 kg	1%	96%	Dry
10	2001	2,330 kg	1%	97%	Dry
11	1999	1,207 kg	1%	98%	Dry
12	2000	1,191 kg	1%	99%	Dry

3.0 In-Lake Nutrient Control Strategies

Historical records and data from sediment core samples indicate that phosphorous levels in Lake Elsinore have been elevated for many centuries.[17] However, there is growing concern that agricultural activities and urban development may cause these natural water quality conditions to worsen.[18] As a result, many studies have been performed to evaluate various nutrient reduction strategies for the lake (see Table 8).

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[15] Michael A. Anderson; Internal Loading and Nutrient Cycling in Lake Elsinore. August 31, 2001. See, also, Anderson, Michael; Lake Elsinore Water Quality Model. 2003

[16] M.A. Anderson; Predicted Effects of Restoration Efforts on Water Quality in Lake Elsinore: Model Development and Results. March 12, 2006. See Table 4 on pg. 17.

[17] Matthew E. Kirby, et al. Developing a Baseline of Natural Lake-Level/Hydrologic Variability and Understanding Past versus Present Lake Productivity Over the Late-Holocene: A Paleo-Perspective for Management of Modern Lake Elsinore. March, 2005.

[18] California Regional Water Quality Control Board -Santa Ana Region. Problem Statement for Total Maximum Daily Load for Nutrients in Lake Elsinore - Staff Report. 2001; See, also, U.S. Geological Survey. Effects of Increased Urbanization from 1970's to 1990's on Storm-Runoff Characteristics in Perris Valley, California. Water-Resources Investigations Report 95-4273. 1996.

Table 8: Key Studies Used to Evaluate and Select Nutrient Reduction Strategies

Date	Report	Author(s)
1994	Lake Elsinore Water Quality Management Plan	Black & Veatch, Inc.
1994	Lake Elsinore Master Plan / Economic Feasibility Study: 1995-2015	Noble Consultants, Inc.
1997	EVMWD: Lake Elsinore NPDES Permit Feasibility Study; Final Phase 1 Technical Report	Montgomery Watson Americas, Inc.
2000	Lake Elsinore Sediment-Water Interface Study Final Report	M. Beutel
2000	Laboratory and Limnocosm-Scale Evaluation of Restoration Alternatives for Lake Elsinore. Final Report.	Dr. Michael A. Anderson
2001	Alum Application to Lake Elsinore: Responses to Questionnaire	Dr. G. Dennis Cooke
2001	Internal Loading and Nutrient Cycling in Lake Elsinore	Dr. Michael A. Anderson
2002	Rainfall-Runoff Characteristics and Effects of Increased Urban Density on Streamflow and Infiltration in the Eastern Part of the San Jacinto River Basin	U.S. Geological Survey Water Resources Report 02-4090
2002	Proposed Lake Aeration and Biomanipulation for Lake Elsinore, CA	Arlo W. Fast
2002	Alum Application to Lake Elsinore: Questionnaire Update	Dr. G. Dennis Cooke
2002	Restoration of Canyon Lake and Benefits to Lake Elsinore Downstream	Dr. Alex J. Horne
2002	Impacts of Alum Addition on Water Quality in Lake Elsinore	Dr. Michael A. Anderson
2002	EVMWD: Engineering Feasibility Study for NPDES Permit for Discharge to Lake Elsinore Final Report	Montgomery Watson Harza, Inc.
2002	Lake Elsinore Replenishment Level Study Alternatives Analysis	Tetra Tech, Inc.
2002	Evaluation of Calcium Treatment for Control of Phosphorus in Lake Elsinore	Dr. Michael A. Anderson
2002	Report on Evaluation of Potential Calcium Treatment to Enhance Water Quality in Lake Elsinore	Dr. Ellie E. Prepas
2003	Lake Elsinore and Canyon Lake Nutrient Source Assessment	Tetra Tech, Inc.
2004	San Jacinto Nutrient Management Plan Final Report	Tetra Tech, Inc.
2004	Lake Elsinore Nutrient Removal Study	CH2M-Hill, Inc.
2004	Removal of Dissolved Phosphorus Using Calcium Amendment	Dr. Michael A. Anderson
2005	Developing a Baseline of Natural Lake-Level/Hydrologic Variability and Understanding Past Versus Present Lake Productivity Over the Late-Holocene: a Paleo-Perspective for Management of Modern Lake Elsinore	Dr. Matthew E. Kirby and Dr. Michael A. Anderson
2005	Lake Elsinore Stabilization and Enhancement Project: Draft PEIR	MWH
2005	Final Fisheries Management Plan for Lake Elsinore	EIP Associates
2006	Predicted Effects of Restoration Efforts on Water Quality in Lake Elsinore: Model Development and Results	Dr. Michael A. Anderson
2006	Feasibility Study Report: Nutrient Reduction Alternatives for Regional Water Reclamation Facility Effluent Discharge to Lake Elsinore	MWH Americas, Inc.
2006	White Paper: Reasons for the TMDL Nitrogen Additional Studies of Lake Elsinore in 2006-07	Dr. Alex J. Horne
2007	Sediment Nutrient Flux and Oxygen Demand Study for Canyon Lake with Assessment of In-Lake Alternatives	Dr. Michael A. Anderson

Some control strategies, such as large-scale dredging, were found to be impractical because it would be necessary to remove 20 feet of sediment to have a significant effect on phosphorus concentrations in the water column.[19] Other methods commonly used elsewhere to control algae, such as applying liquid alum to bind with phosphorus and render it inert, are relatively ineffective for Lake Elsinore due local water chemistry conditions (high pH) which are ill-suited to such treatments except, perhaps, during short periods of time immediately following a storm event.[20]

Relying on the large volume of technical reports prepared by interdisciplinary experts in lake management, local stakeholders developed an innovative new approach for improving water quality in Lake Elsinore. The approach, called "Biomanipulation," implements several coordinated projects designed to reduce phosphorus loads from in-lake sediments. The three primary mitigation strategies are: 1) a Lake Level Stabilization program, 2) an In-Lake Aeration System, and 3) a Targeted Fisheries Management effort.

3.1 Lake Level Stabilization

Water levels in Lake Elsinore vary over a wide range (±18 ft.) due to natural fluctuations in rainfall. During times of prolonged drought, such as occurred in the mid-50's and early 60's, the lake nearly dried up altogether. As evaporation diminishes the volume of lake water, conservative elements such as phosphorus become more concentrated. Elevated nutrient concentrations, in turn, increase the risk of beneficial use impairment. Large changes in lake elevation also make it very difficult to establish a stable riparian zone along the shoreline.

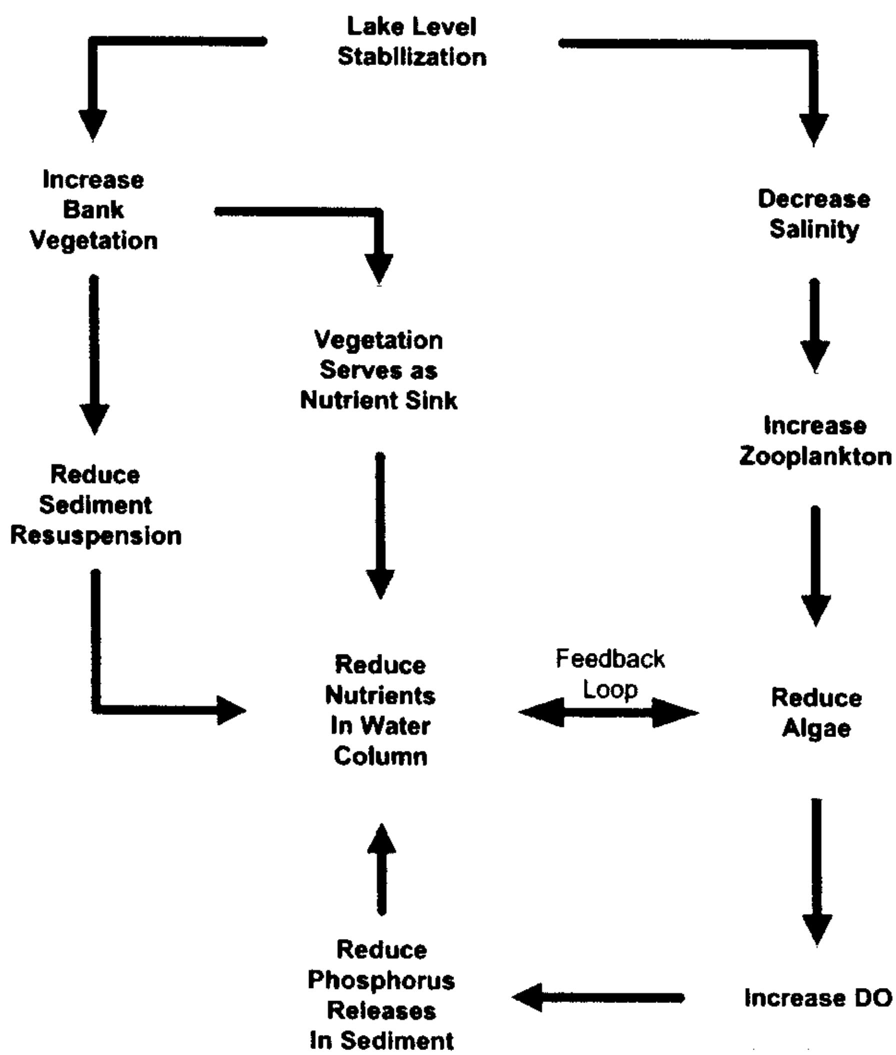
In 1995, a large levee was constructed to reduce the surface area of Lake Elsinore by nearly 50% thereby minimizing the adverse effects of evaporation. However, by itself, even this drastic reconfiguration is insufficient to provide the stable lake levels. Supplemental flow is provided by several island wells which pump 3,000 acre-feet of groundwater into the lake each year.

In June of 2007, Elsinore Valley Municipal Water District (EVMWD) agreed to augment lake levels by discharging high quality reclaimed water to Lake Elsinore. By stabilizing lake levels in a range between 1240-1248 feet above mean sea level, the supplemental water project will establish the conditions necessary to promote more productive shoreline vegetation. The direct and indirect environmental benefits of such bank habitat are numerous.

[19] See Table 5-2 on page 5-4 of Montgomery-Watson's Final Report entitled: "Engineering Feasibility Study for NPDES Permit for Discharge to Lake Elsinore." February, 2002.
[20] See, for example, G. Dennis Cooke. Alum Applications to Lake Elsinore. 2001 & 2002. See, also, CH2M-Hill. Lake Elsinore Nutrient Removal Study. April, 2004

First, aquatic plants shield the underlying sediments from wind-driven waves and, thereby, reduce the phosphorus releases that accompany resuspension. Second, the aquatic plants themselves take up and sequester nutrients that would otherwise contribute to excess algae growth. Third, the aquatic plants provide the type of habitat needed to support a stronger and more diverse community of aquatic species (see Fig. B).

Fig. B: Biological Benefits of Lake Level Stabilization



The last point is especially important. Some aquatic organisms, such as zooplankton, feed on algae thus helping to prevent beneficial use impairment. However, zooplankton reproduction is inhibited at the higher salinity levels likely to occur as water evaporates from Lake Elsinore. By providing supplemental flows of reclaimed water, Elsinore Valley MWD is stabilizing both the lake level and the salinity concentration in a range that promotes a healthy zooplankton population.

However, municipal effluent also contains elevated concentrations of nutrients such as nitrogen and phosphorus (see Tables 4 & 5, above). Consequently, the TMDL requires EVMWD to reduce nitrogen concentrations by 87% and phosphorus concentrations by 75% before the reclaimed water can be discharged to Lake Elsinore. These obligations are set forth and enforceable though a state and federal NPDES permit. In 2005, the Lake Elsinore and San Jacinto Watersheds Authority (LESJWA) provided funding from the State of California Prop-13 Water Bond to contract with EVMWD to construct advanced waste treatment facilities, using best available technology, to reduce nutrient concentrations in the effluent. Such treatment is essential to support a long-term strategy for providing reclaimed water to stabilize the level of Lake Elsinore.

Computer simulation studies, designed to model nutrient cycling processes in Lake Elsinore, indicate that adding 4000 af/yr of highly treated reclaimed water will reduce the algae concentrations by more than 50% and improve water clarity by nearly 100%.[21] These estimates are probably conservative because they are based solely on the expected benefit derived by reducing wind and wave-driven sediment resuspension. Increased zooplankton populations and enhanced shoreline vegetation are also expected to improve water clarity and reduce excessive algae. At present, there is insufficient data to calibrate the nutrient models to estimate all of the cause-effect relationships. However, on-going monitoring programs will be used to perform an empirical analysis of these biological factors over the long-term.

3.2 <u>In-Lake Aeration and Destratification</u>

Dissolved oxygen levels in Lake Elsinore vary greatly by depth; concentrations range from less than 1 mg/L near the bottom to over 11 mg/L near the surface. Low D.O. levels encourage greater phosphorus releases from the sediment. The higher phosphorus concentrations stimulate more algae growth which, in turn, consumes more oxygen especially during the nighttime hours. Nutrient cycling is now the principle cause of water quality impairment in Lake Elsinore.

[21] M.A. Anderson. Predicted Effects of Restoration Efforts on Water Quality in Lake Elsinore: Model Development and Results. March 12, 2006.

LESJWA undertook an evaluation of the necessary aeration and oxygenation system for Lake Elsinore and contracted with Dr. Arlo Fast to make appropriate recommendations. Dr. Fast's report indicated that sufficient oxygen already exists but was not well distributed in the water column.[22] He recommended a two phase mixing system to distribute and mix the oxygen throughout the water column.

The first phase of the system consisted of axial flow water pumps. The system was implemented in 2005 by the City of Lake Elsinore under contract with LESJWA with significant financial support provided by California's Prop-13 Water Bond.[23] The pumps are designed to reduce stratification by improving circulation in the lake. Forcing oxygen-saturated surface waters to the bottom of the lake inhibits the anoxic conditions that promote higher phosphorus release rates from the sediment.

The second phase consisted of a large-scale in-lake aeration system.[24] In June of 2007, LESJWA provided Prop-13 Water Bond funding to EVMWD to construct an in-lake aeration project is designed to pump air through a system of twelve perforated pipelines submerged along the bottom of Lake Elsinore (see Fig D). Like the axial pump, the aeration system improves circulation so that oxygen levels are better distributed throughout the water column. The bubble diffuser "lifts" oxygen-deficient bottom waters to the surface where it can be resaturated through direct contact with the atmosphere.

The aeration pumps are only scheduled to operate during the warm-weather months when oxygen levels are lowest, nutrient levels are highest, daylight hours are longest and algae growth is greatest. Additional water quality benefits may accrue if the system is run more frequently; however, it is considerably less efficient to operate outside the optimum range. Moreover, it may be unnecessary.

Laboratory testing indicates that the in-lake aeration system will reduce the sediment release rate for phosphorus by at least 35%.[25] However, computer simulation studies suggest that a 35% reduction in the sediment recycling rate may result in larger reductions for total phosphorus in the water column – perhaps as much as 70% lower.[26] Figure C illustrates how the benefits are expected to accrue.

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[22] Arlo W. Fast. Proposed Lake Aeration and Biomanipulation for Lake Elsinore, CA. 2002

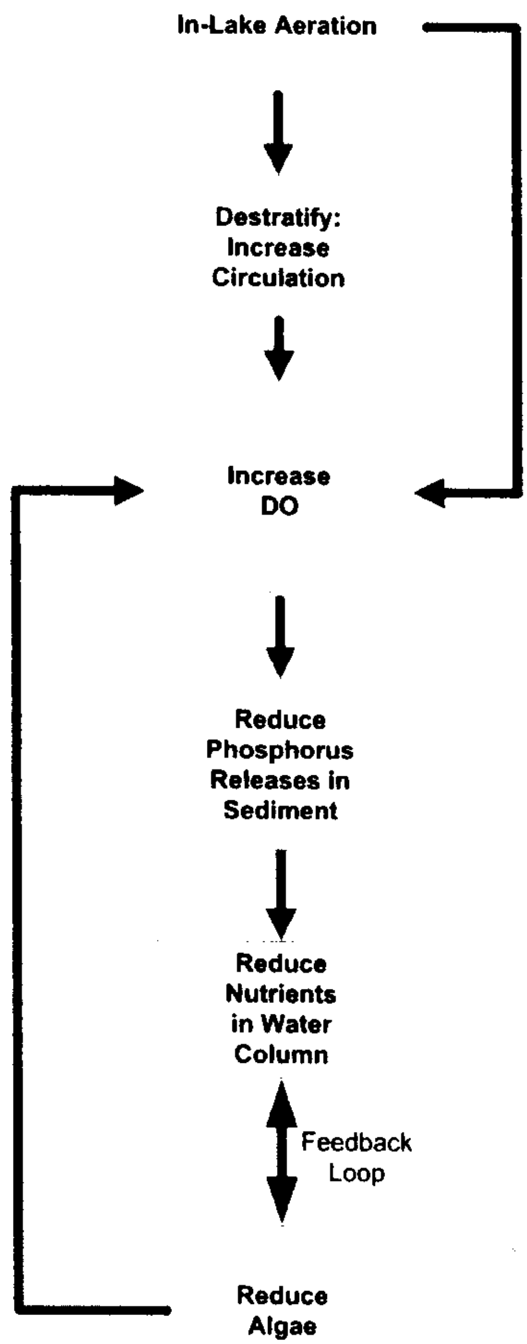
[23] Agreement for the Operations and Maintenance of the Axial Flow Water Pump Destratification System for Lake Elsinore. Feb. 11, 2003. Signatories: City of Lake Elsinore, Elsinore Valley Municipal Water District, & County of Riverside.

[24] Agreement for the Operation and Maintenance of the Lake Elsinore Phase II Aeration System. Aug. 1, 2006. Signatories: City of Lake Elsinore, Elsinore Valley Municipal Water District, & County of Riverside.

[25] Michael A. Anderson. Internal Loading and Nutrient Cycling in Lake Elsinore. Aug. 31, 2001.

[26] M.A. Anderson. Predicted Effects of Restoration Efforts on Water Quality in Lake Elsinore: Model Development and Results. March 12, 2006. p. 25

Fig. C: Biological Benefits of In-Lake Aeration



The Santa Ana Regional Water Quality Control Board assumed the in-lake aeration and mixing systems would reduce phosphorus loads by 35% and included this assumption when formulating the TMDL for Lake Elsinore.[27] The County of Riverside, the City of Lake Elsinore and Elsinore Valley MWD have committed to continue operating the in-lake aeration and mixing systems until mid-2011. Data from the first four years of operation will be used to determine the overall effectiveness of the system. Based on this information, a new agreement will be negotiated among the responsible parties identified in the TMDL to govern future operations of the system. The new agreement will be submitted to the Santa Ana Regional Water Quality Control Board for approval in December, 2010.

3.3 Targeted Fisheries Management

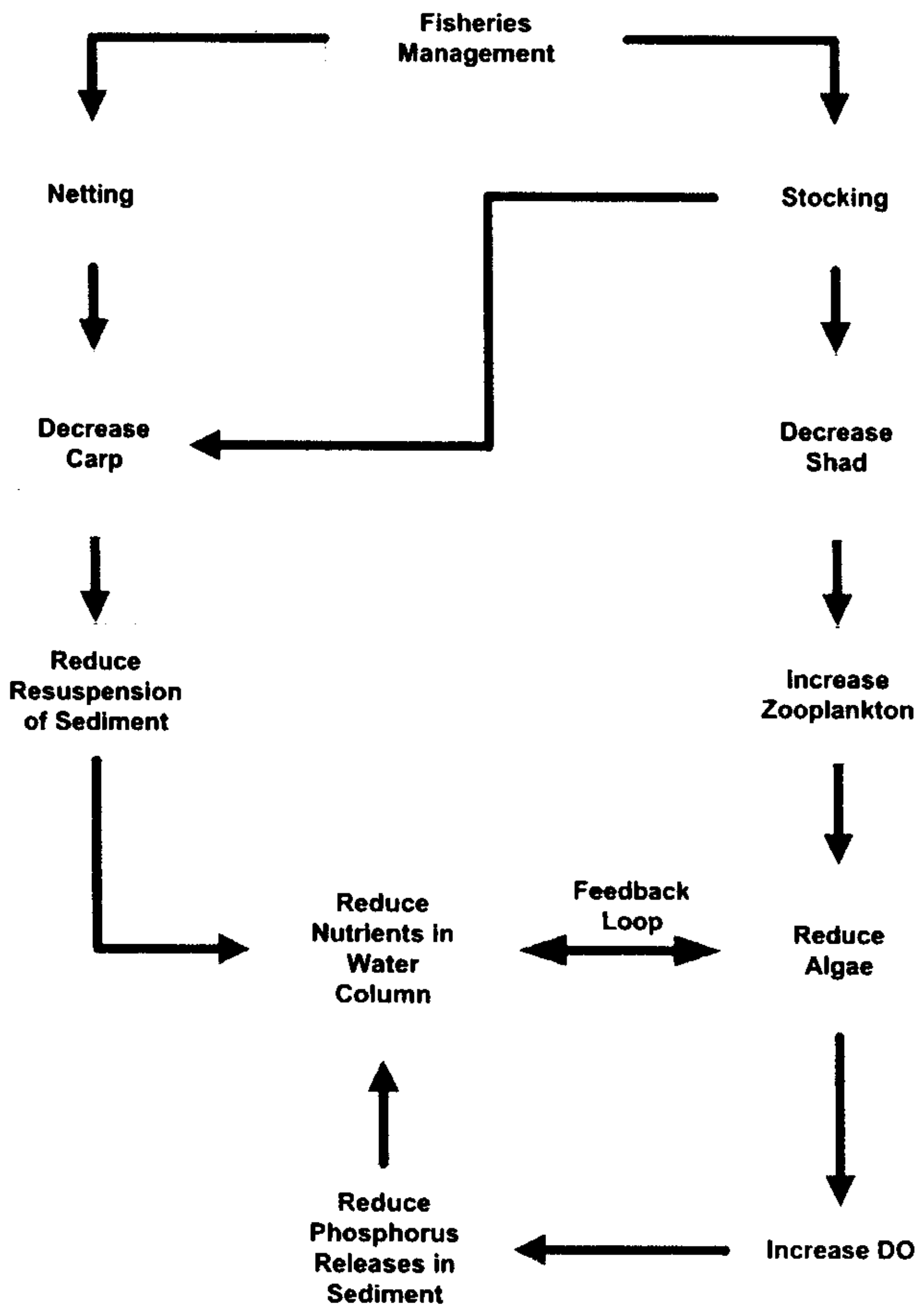
Some fish species, notably Carp and Shad, are seriously aggravating the nutrient problem in Lake Elsinore. Carp forage for food in the sediment. This action, called "bioturbation," resuspends organic silt and thereby increases the amount of phosphorus released to the water column by as much as 5,000 kg/yr ($\approx$ 5% of the total load). Shad consume the zooplankton species that would normally keep the algae population in check.

In order to improve water quality in Lake Elsinore, and provide better habitat or a wider range of fish species, it is necessary to reduce the number of Carp and Shad significantly. This will be accomplished by using direct and indirect methods (see Fig. D).

Direct methods are best exemplified by the City of Lake Elsinore's netting and stocking program. Each year, LESJWA provides Prop-13 Water Bond funding to support a large-scale netting effort designed to reduce the Carp population. The City also stocks the lake with sport fish (such as Stripers) that feed on Carp and Shad and out-compete the nuisance species for available habitat. Early indications are that these efforts have significantly reduced the number of both nuisance species and, in turn, helped improve water quality in the lake despite the influx of new sediment loads during the relatively wet winters of 2005 and 2006. Prop-13 funding will end in 2010; thereafter, local stakeholders must provide financial support for the program if it continues to prove effective. If so, the responsible parties identified in the TMDL will negotiate a long-term contract to extend the fishery management program (netting and stocking) and submit the agreement to the Santa Ana Regional Water Quality Control Board by December, 2010.

[27] California Regional Water Quality Control Board - Santa Ana Region. Lake Elsinore and Canyon Lake Nutrient TMDL Technical Report. 2004.

Fig. D: Biological Benefits of Targeted Fisheries Management



Indirect methods are best illustrated by EVMWD's flow augmentation program. Stabilizing the lake level with reclaimed water will improve shoreline vegetation that provides habitat for desirable zooplankton and fish species. In addition, the reclaimed water will help control salinity concentrations in a range more favorable to the zooplankton. A large population of zooplankton is essential to prevent excessive algae growth in Lake Elsinore.

Computer simulation studies indicate that reducing Carp populations by 50% will lower the phosphorus loading rate by 5 $mg/m^2/day$ (nearly 13%).[28] Reducing the Carp population by 75% will lower the phosphorus loading rate by 16 $mg/m^2/day$ (32%). At present, the simulation models cannot quantify the benefits of increasing the zooplankton population by decreasing water salinity and the number of Shad in Lake Elsinore. However, the long-term monitoring program is designed to track such phenomena and the computer programs can be updated when the data become available.

3.4 Compound Effects

The nutrient targets specified in the TMDL can be achieved by implementing several remediation measures simultaneously. For example, installing the aeration system and reducing the Carp population by 50% will decrease the phosphorus loading rate by 78%.[29] This estimate is conservative because it assumes the total phosphorus concentration in recycled water is 2 mg/L rather than the 0.5 mg/L allowed by permit. In addition, it does not include the expected benefits derived from higher lake levels or larger zooplankton populations.

Biomanipulation is a complex implementation strategy with many inter-related cause and effect relationships. The cumulative beneficial impact of this integrated remediation effort is actually greater than the sum of the individual interventions.

Ultimately, compliance must be assessed using actual water quality monitoring data not the results of sophisticated computer simulations. And, such a monitoring program is already underway. Nevertheless, analysis-to-date indicates that the on-going biomanipulation strategy will restore water quality in Lake Elsinore to better than natural background conditions.

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[28] M.A. Anderson. Predicted Effects of Restoration Efforts on Water Quality in Lake Elsinore: Model Development and Results. March 12, 2006. p. 25

[29] M.A. Anderson. Predicted Effects of Restoration Efforts on Water Quality in Lake Elsinore: Model Development and Results. March 12, 2006. p. 25

4.0 Compliance Monitoring

The monitoring program proposed for Lake Elsinore is not merely designed to demonstrate compliance with the numeric nutrient targets identified in the TMDL but, also, to show that the beneficial uses themselves are being attained. To that end, many different parameters are evaluated simultaneously to better assess the health of Lake Elsinore's aquatic ecosystem.

4.1 Water Quality Monitoring

The most direct method of establishing compliance with water quality objectives in the Basin Plan is to collect and analyze water samples on a regular basis. The TMDL requires samples to be collected from at least three stations in Lake Elsinore. The samples are to be collected monthly between October and May and biweekly in the months of June through September.[30] In addition to other parameters, samples are analyzed for all of constituents listed in Table 9.

Table 9: In-Lake Water Quality Monitoring Program for Lake Elsinore

Category	Parameter
Oxygen	Dissolved Oxygen*
	Chemical Oxygen Demand (COD)
	Biological Oxygen Demand (BOD)
Water Clarity	Secchi Depth
	Turbidity
	Total Suspended Solids (TSS)
	Chlorophyll *a**
Nutrients	Ortho-phosphate (SRP)*
	Organic Phosphorus*
	Organic Nitrogen*
	Nitrite Nitrogen*
	Nitrate Nitrogen*
	Ammonia Nitrogen*
Salinity	Total Dissolved Solids (TDS)
	Specific Conductance
	Total Hardness
Physical	pH
	Water Temperature

**Indicates a parameter that must meet specific numeric targets identified in the TMDL. Nutrient parameters are summed into Total Phosphorus and Total Nitrogen.*

[30] A more detailed description is provided in the Proposed Lake Elsinore and Canyon Lake Nutrient TMDL Monitoring Plan (Feb. 15, 2006) approved by the Regional Board on March 3, 2006 as Resolution No. R8-2006-0031.

Results from the water quality monitoring program will be compared to the numeric targets identified in the TMDL, using the methods and procedures specified in the State Water Resources Control Board's 303(d) listing policy.[31] In addition, the data may be used to update and revise the various computer simulation models used to predict changes in water quality in Lake Elsinore.

4.2 Biological Monitoring

The primary purpose of improving water quality in Lake Elsinore is to protect aquatic organisms. Although one may infer that lower nutrient concentrations and high DO levels are beneficial to fish and other species living in the lake, it is desirable to demonstrate such improvements more directly. This is especially important when implementing strategies designed to mitigate the adverse effects of pollution rather than relying, exclusively, on pollution reduction programs. For example, it may be more efficient and effective to control algae by stimulating the zooplankton population than it is to reduce phosphorus concentrations. The In-Lake Nutrient Reduction Plan for Lake Elsinore intends to pursue both of these strategies in addition to several other compliance initiatives. And, as a result, it is likely that beneficial uses will be protected (e.g. response targets will be attained) even if nutrient targets are not always met.

Some response variables, such as D.O. and Chlorophyll-a, are already included among the parameters that must be evaluated as part of the regular water quality monitoring program. Compliance with these TMDL targets would form the primary basis for assessing beneficial use protection . However, there are other indicators of biological integrity which should also be considered (see Table 10). A plan to expand the current monitoring program to include additional biological monitoring will be submitted to the Regional Board by June of 2008.

Table 10: Recommended Biological Monitoring Program for Lake Elsinore

Parameter	Frequency
Fish Richness and Abundance	Annually
Zooplankton Abundance	Annually
Algae Richness and Abundance	Annually
Shoreline Vegetation Survey	Bi-annually
Aquatic Plant Survey	Bi-annually

[31] California State Water Resources Control Board. Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List. September 30, 2004.

Results from the biological monitoring program will be used to recalibrate the computer simulation models used to predict changes in DO or algae concentrations based on changes in nutrient levels while controlling for other important variables such as the size of various fish and plant populations. Ultimately, as water quality improves, biological monitoring data may be used to demonstrate that DO and algae levels are better than would occur under natural conditions and that beneficial uses in Lake Elsinore are no longer impaired. In addition, results from the biological monitoring program will be invaluable for developing "biocriteria," an essential element of TMDL Task #13 (Reviewing and Revising Nutrient Water Quality Objectives."

4.3 Special Studies

Although the TMDL does not require the In-Lake Sediment Nutrient Reduction Plan to meet specific load allocations for total nitrogen, the Regional Board staff has indicated that some nitrogen-reduction benefits were expected to occur when the aeration system is installed. Therefore, some special studies have been initiated to provide additional scientific confirmation.[32] These include:

1) In-lake measurements of the sediment organisms as a living sink for Nitrogen.

2) Estimation of sediment denitrification as an atmospheric sink for Nitrogen.

3) In-lake samples of the nitrogen fixing potential of the lake as a source for Nitrogen.

EVMWD contracted with Dr. Alex Horne to perform the studies and initial samples were collected in September, 2006. Additional sampling is expected to be conducted in the Fall of 2007. Results will be reported to the Regional Board.

[32] Alex J. Horne. White Paper: Reasons for the TMDL Nitrogen Additional Studies of Lake Elsinore in 2006-07. August 14, 2006.

4.4 Water Quality Modeling

All of the additional monitoring data described above is a necessary prerequisite to completing TMDL Task #11: Updating the Lake Elsinore In-Lake Water Quality Model.[33] Until the aeration system comes on-line, and new data are collected, there is little value in running the current water quality models for Lake Elsinore. Therefore, the Regional Board has extended the deadline to March of 2009 in order to collect additional chemical and biological data.[34]

5.0 Supplemental Control Strategies

The biomanipulation program described in Section 3 is expected to achieve compliance with the chemical and biological targets specified in the TMDL. However, in the event the proposed program proves inadequate, there may be additional options to further reduce nutrient loads released from in-lake sediments. These include:

5.1) An Enhanced Aeration System

The software code used to control the existing aeration system can be revised to operate the aerators more frequently (more months of the year, more days of the month, or more hours in a day). In addition, additional pipelines and/or aerators may be installed to provide better coverage. The utility of this option depends on the demonstrated effectiveness of the current aeration system and the related oxygenation efficiency curve of additional aeration.

5.2) Enhanced Treatment of Reclaimed Water

EVMWD's NPDES permit limits phosphorus concentrations in reclaimed water discharged to Lake Elsinore to less than 0.5 mg/L. Additional alum application at the wastewater treatment plant may reduce nutrient concentrations even further. This may provide any opportunity to offset non-point source loads by engaging in pollutant trading with point sources.

[33] Source: Table 5-9s on pg. 7 of 21 in R8-2004-0037.

[34] California Regional Water Quality Control Board - Santa Ana Region. Letter to Mr. Mark Norton, Lake Elsinore & San Jacinto Watersheds Authority dated April 30, 2007.

5.3) Direct Application of Metal Salts

Alum and other metal salts are frequently used to reduce phosphorus concentrations in small lakes. In general, Lake Elsinore is poorly suited for the use of alum because the relatively high pH levels inhibit the intended formation of aluminum phosphate.[35] However, under certain conditions, pH levels may be low enough to support the application of metal salts, such as alum, to Lake Elsinore.

In very wet years, when the inflows to Lake Elsinore are greatest, pH levels tend to decrease. This is not surprising because the pH of rain water is naturally low. If large scale alum applications were timed to coincide with wet winters, much of the new dissolved phosphorus flowing into the lake might be neutralized. Another option may be to apply alum to Canyon Lake and reduce the phosphorus concentrations before the water overflows into Lake Elsinore.[36]

5.4 Targeted Suction Dredging

Previous studies indicate a disproportionate amount of phosphorus released from in-lake sediments is coming from the organic silt layer in the middle of the lake.[37] And, preliminary reports suggest that most of the phosphorus is coming from the top 15 cm of sediment. Therefore, limited suction dredging, targeting the top 6 inches of sediment in the middle of the lake may prove to be an effective mitigation strategy.

5.5 Constructed Wetlands

LESJWA is currently developing a pilot project to demonstrate the effectiveness of constructed wetlands for reducing nutrient concentrations in Lake Elsinore. Theoretically, stormwater runoff could be diverted through such wetlands for treatment prior to entering the lake. Alternatively, lake water could be pumped up and flow through the wetlands during drier years. When the levee was constructed, and the surface area of Lake Elsinore was cut in half, a large back-basin area was created that may serve as an ideal location to build treatment wetlands. Data from the pilot project will help determine whether such an approach would be practical on a larger scale.

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[35] Michael A. Anderson. Impacts of Alum Addition on Water Quality in Lake Elsinore. Feb. 1, 2002.

[36] These and other alternatives are described in CH2M-Hill's report entitled: Lake Elsinore Nutrient Removal Study. April, 2004.

[37] California Regional Water Quality Control Board - Santa Ana Region. Lake Elsinore and Canyon Lake Nutrient TMDL Technical Report; 2004 @ pgs. 29-31.

5.6 Active Aquatic Plant Management

Over time, stabilizing the lake level and reducing the algae infestation will provide an opportunity for native aquatic plants to recolonize the lake. It may also be possible to accelerate the process by initiating a program to actively revegetate the shoreline and the lake bottom. Aquatic plants will serve as a natural sink for nutrients, will provide better habitat for beneficial freshwater species, and reduce the level of sediment resuspension caused by wind and wave action.

5.7 Enhanced Fishery Management Program

The City of Lake Elsinore has demonstrated the general effectiveness of actively managing the fish populations through netting and stocking programs. Such programs, particularly stocking efforts, could be significantly expanded if there were a way to calculate and credit the nutrient-removal credit associated with such an effort. Data collected from the water quality monitoring program may provide the information needed to validate the beneficial use protection value and, thereby, create an incentive to augment the City's fishery management program.

5.8 Enhanced Lake Stabilization

Previous studies revealed that 13-15,000 acre-feet of water evaporates each year from Lake Elsinore.[38] On average, only about 1,400 acre-feet flows into Lake Elsinore annually. The island wells provide an additional 3,000 acre-feet of groundwater and reclaimed water adds 5,000 acre-feet of supplemental flow each year. Therefore, more water (up to 5,000 acre-feet/year) may be needed to fully offset evaporative losses and stabilize the lake level in the ideal range. The most cost-effective and reliable source is high quality reclaimed water from local wastewater plants. However, additional treatment would be necessary to reduce nutrient concentrations to acceptable levels before more reclaimed water could be added to Lake Elsinore. And, the cost of such treatment would have to be heavily subsidized by the responsible parties named in the TMDL.

[38] See Section 3 in CH2MHill's "Lake Elsinore Nutrient Removal Study;" April, 2004.

5.9 Pollutant Trading

Many of the supplemental control strategies seek to restore and protect beneficial uses through indirect means. Consequently, it is necessary to develop a system which can accurately assess the benefits and correctly credit those responsible for implementing these strategies. In fact, Task 12 of the TMDL envisions creating just such a system.[39]

The TMDL requires stormwater management agencies to employ Best Management Practices to minimize pollutants in urban runoff. However, as a practical matter, it may be infeasible to divert or treat the immense volume of urban runoff flowing to Lake Elsinore during wet years. Therefore, another way to comply with external load reductions mandated in the TMDL is to mitigate the negative effects after the nutrients enter Lake Elsinore but before the pollutants begin to impair beneficial uses.

This condition creates a strong economic incentive for the parties responsible for achieving external load reductions to fund offset programs designed to reduce internal nutrient loads. For example, if an appropriate credit can be affirmed by the Regional Board, it may be more cost-effective for stakeholders to operate the aerators more frequently, or apply alum intermittently, or dredge selectively then to build the infrastructure necessary to intercept urban or agricultural runoff to Lake Elsinore. Other nutrient offset programs may be available if a stakeholder were willing to fund additional efforts to reduce phosphorus concentrations in EVMWD's reclaimed water before it is discharged to Lake Elsinore.

The utility of a pollutant trading program depends on three things: 1) the need to further reduce nutrient concentrations in order to comply with the TMDL; 2) the availability of a cost-effective offset opportunity; and 3) regulatory acceptance of the offset trade as an alternative means of demonstrating legal compliance. Data from the on-going monitoring program will be needed to support all three. Therefore, the Regional Board has extended the deadline for submitting a Pollutant Trading Plan until Spring of 2009 so that the necessary information may be collected.

5.10 Other Alternatives

Previous reports have suggested other alternatives that may also be reevaluated in the future. These include: dredging, algae harvesting, sediment sealing, dye shading, dilution/flushing, selective withdrawal of low DO waters from lake bottom, etc.[40]

[39] Source: Table 5-9s on pg. 7 of 21 in R8-2004-0037.

[40] See, for example, Table 5-2 on page 5-4 of report prepared by Montgomery-Watson entitled "Engineering Feasibility Study for NPDES Permit for Discharge to Lake Elsinore." February, 2002.

6.0 Implementation Schedule

The In-Lake Sediment Nutrient Reduction Plan for Lake Elsinore is divided into two phases. Phase 1, to stabilize lake levels, install aerators and initiate a fishery management strategy, is well underway. If, as expected, Phase 1 is successful, then there is no need to develop Phase 2 implementation strategies. There will, however, be a need to ensure that the previous projects continue to operate effectively.

If the monitoring program demonstrates that Phase 1 efforts fail to meet the targets identified in the TMDL, then a Phase 2 implementation strategy will be required. Phase 2 will likely focus on one or more of the Supplemental Control Strategies described in Section 5. However, it is not possible to predict, with any certainty, the order in which these strategies might be implemented. Too much depends on the monitoring results from Phase 1 and the related modeling predictions.

The load allocations and wasteload allocations specified in the TMDL are expressed and 10-year rolling averages and compliance with final targets is required by the year 2020. Compliance with the 10-year rolling average will be determined beginning with water quality data collected in 2011. In addition, responsible parties must demonstrate compliance with the interim targets for some of the response variables (e.g. DO & Chlorophyll-A) by 2015. Therefore, stakeholders must make a decision by 2010 as to whether additional efforts will be needed to meet the TMDL targets on schedule. Table 12 provides a more detailed schedule to guide both Phase 1 and 2.

7.0 Summary

Lake Elsinore is a dynamic and complex ecosystem. Manipulating several chemical and biological variables simultaneously to improve water quality and restore beneficial uses is an ambitious and somewhat daunting task.

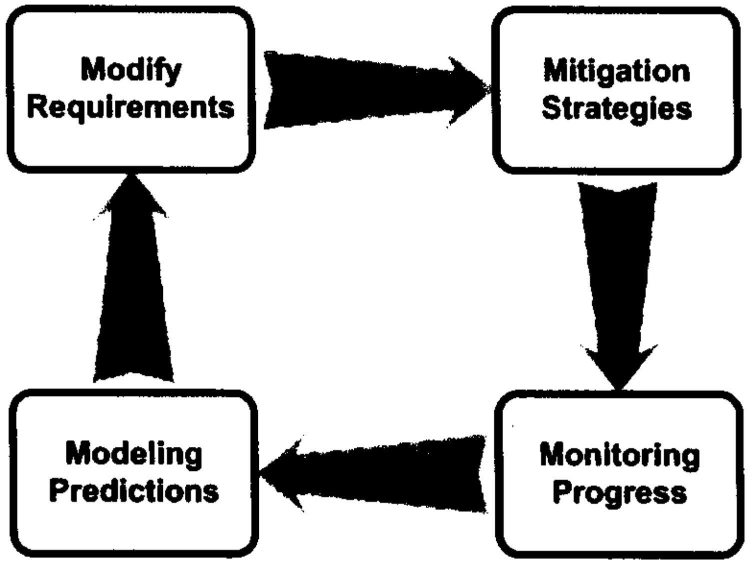
It is unlikely that the stakeholders will implement the perfect solution on the first try. Rather, success will depend on an iterative process of developing mitigation projects, measuring results, updating the predictive models and refine the follow-on strategy. This process of "adaptive implementation" makes best use of scarce public resources and reduces the risk of unforeseen consequences by emphasizing incremental changes.

Table 11: Schedule for Lake Elsinore In-Lake Sediment Nutrient Reduction Plan

Phase	Task Description	Deadline
1	Install Aeration & Axial Flow Pump Mixing Systems	Complete
1	Supplemental Reclaimed Water Flows	Complete
1	Submit Preliminary Plan to Update Water Quality Models*	Complete
1	Submit Preliminary Pollutant Trading Plan*	Complete
1	Revise and Update WDRs and MS4 Permits	Mar., 2008
1	Revise Monitoring Plan to include Biological Sampling Program	June, 2008
1	Summarize Results of Monitoring Program	Aug., 2008
1	Summarize Results of Monitoring Program	Aug., 2009
1	First TMDL Review	Nov., 2009
1	Review Nutrient Water Quality Objectives	Mar., 2010
1	Summarize Results of Monitoring Program	Aug., 2010
1	Update Water Quality Models	Nov., 2010
1	Submit O & M Agreement for Fishery Management Program	Dec., 2010
1	Submit O & M Agreement for Aeration & Mixing Systems	Dec., 2010
1	Submit Phase 2 Implementation Alternatives	Dec., 2010
2	Begin data collection to calculate 10-year rolling average	Jan., 2011
2	Submit Phase 2 Projects Plan	June, 2011
2	Summarize Results of Monitoring Program	Aug., 2011
2	Second TMDL Review	Nov., 2012
2	Revise & Update WDRs and MS4 Permits	Mar., 2013
2	Summarize Results of Monitoring Program	Aug., 2013
2	Summarize Results of Monitoring Program	Aug., 2014
2	Complete Phase 2 Project Implementation	Dec., 2014
2	Summarize Results of Monitoring Program	Aug., 2015
2	Third TMDL Review	Nov., 2015
2	Compliance Deadline for Interim Targets (DO & Chlorophyll-a)	Dec., 2015
2	Summarize Results of Monitoring Program	Aug., 2016
2	Summarize Results of Monitoring Program	Aug., 2017
2	Revise and Update WDRs & MS4 Permits	Mar., 2018
2	Summarize Results of Monitoring Program	Aug., 2018
2	Fourth TMDL Review	Nov., 2018
2	Summarize Results of Monitoring Program	Aug., 2019
2	Summarize Results of Monitoring Program	Aug., 2020
2	Compliance Deadline for 10-year Rolling Averages (N, P, NO3)	Dec., 2020
2	Final TMDL Review (De-Listing Petition)	Dec., 2021

* More detailed schedules to complete Updates to the Watershed and In-Lake Nutrient Models (TMDL Task #11) and the Pollutant Trading Program (TMDL Task #12) were submitted to the Regional Board in separate plans as required by Resolution No. R8-2004-0037.

Fig. E: Adaptive Management to Protect Lake Elsinore



Using the lake as a laboratory, successful projects can be repeated or expanded. Unsuccessful projects can be terminated and resources shifted to alternative approaches. Moreover, as additional data becomes available, the ability to accurately assess the lake's true potential, and the steps necessary to achieve that potential, will also improve.

By adopting the TMDL, and the related load allocations and wasteload allocations, the Santa Ana Regional Water Quality Control Board established a baseline set of expectations about the actions needed to meet the water quality objectives for Lake Elsinore. It will be necessary to reduce nutrient loads from both internal and external sources in order to comply with the TMDL.

The multi-pronged approach initiated in Phase 1 (e.g. lake stabilization, aeration/mixing, and fishery management) is expected to achieve the necessary internal load reductions. Implementing Best Management Practices (BMPs) as the watershed is developed is expected to reduce external loads sufficiently. However, some nutrient loading to Lake Elsinore comes from natural sources that cannot be easily controlled and responsibility cannot be easily assigned.

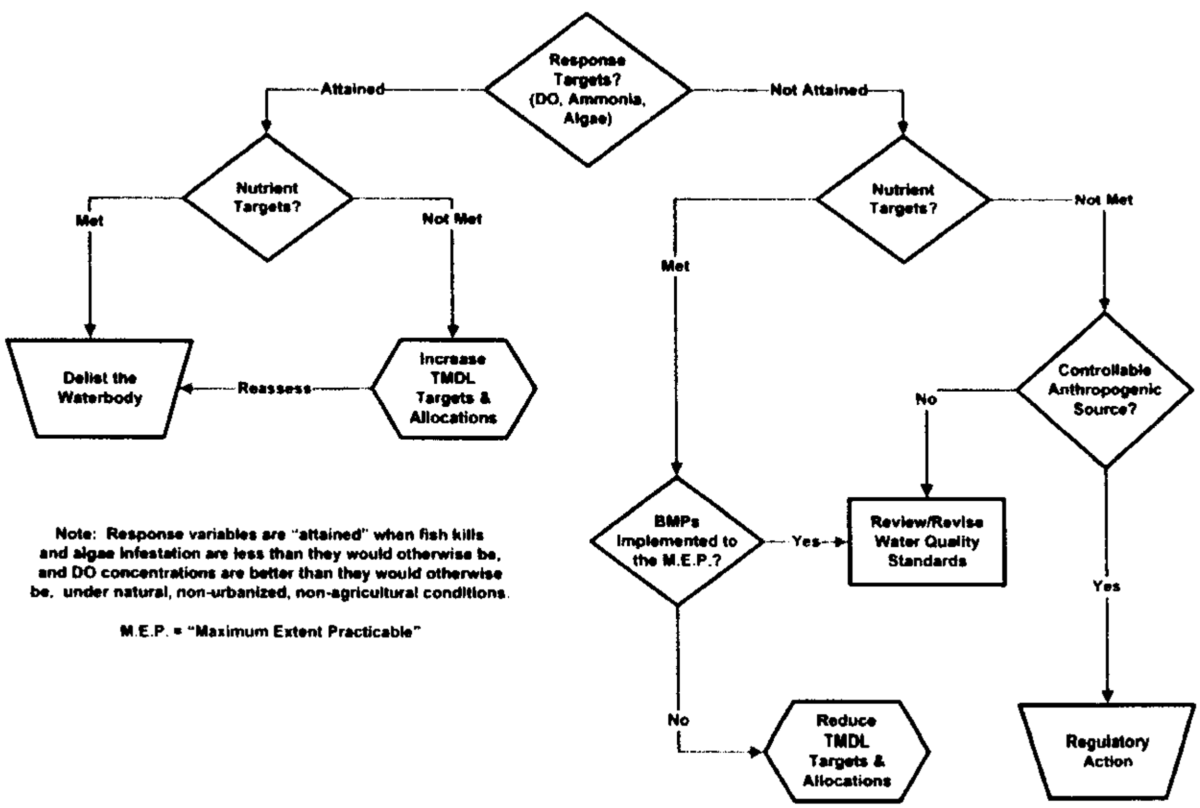
Therefore, it is useful to maintain a high level of flexibility to reallocate loads between point and non-point sources, to raise or lower water quality objectives, and to modify TMDL targets as necessary to ensure that beneficial uses are protected. The true end-goal is to prevent fish kills and excessive algae growth that interferes with recreational opportunities (see Table 13).

Table 12: Hierarchy of Use Impairment Indicators

Use Impairment	Aquatic Organisms	Human Recreation
Level 1 Indicator	Significant Fish Kills	Significant Illness
Level 2 Indicator	Species Richness & Abundance	User Acceptance
Level 3 Indicator	Un-ionized Ammonia & DO	Aesthetic Conditions
Level 4 Indicator	Algae Concentrations	Algae Concentrations
Level 5 Indicator	Nutrient Concentrations	Nutrient Concentrations

Achieving specific nutrient concentrations is a means to an end, not an end in itself. Success will be measured as much by increased public enjoyment of the lake and by greater richness and abundance of aquatic organisms as by chemical analyses. Adaptive management is designed to achieve those goals. Biological and chemical monitoring results will be reviewed annually and the TMDL targets and allocations will be reviewed every three years to maintain that "real-world" focus (see Fig. F).

Fig. F: TMDL Review Process



Attachment D.

Canyon Lake Sediment Nutrient Treatment Evaluation Plan

Sediment Nutrient Flux and Oxygen Demand Study for Canyon Lake with Assessment of In-Lake Alternatives

Final Report

Submitted to:

San Jacinto River Watershed Council
2160 Santa Anita Road
Norco, CA 92860
Attn: Pat Boldt

Submitted by:

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June 25, 2007

Introduction

Canyon Lake is a warm monomictic lake that is impaired by nutrients and pathogens. The lake can be separated into a small north basin that receives San Jacinto River flow and two southern basins – the shallow East Bay, which has high algal turbidity and low transparency, and the larger deeper main basin with greater transparency (Anderson and Oza, 2003). The deeper main basin of the lake (Z_{max} = 13-15 m) maintains thermal stratification with an anoxic hypolimnion that persists for approximately 8 months of the year, while shallow East Bay is mostly well-mixed and oxic.

Sediment properties were previously found to vary across the basin, with higher concentrations of C, N, P, S and $CaCO_3$ in the finest sediments (>60% clay-sized particles) that were principally located in the deeper regions of the main basin of the lake and occupied 31% of the lake bottom (Anderson and Oza, 2003). Coarse-grained sandy sediments were generally found close to the shoreline and in shallow embayments and comprised about 21% of the lake bottom, while silty sediments were mostly concentrated in East Bay and occupied an estimated 48% of the total area in the lake. The silty sediments of East Bay and other shallow embayments had greater rates of nutrient release, based on core-flux measurements than either the shallow sandy sediments or the deeper (colder) profundal sediments (average value of 15.1 $mg/m^2/d$ vs. 6.3 and 6.5 $mg/m^2/d$, respectively). Internal recycling of N proceeded at an annual average rate approximately 4x that of P (23 - 35 $mg/m^2/d$). Accumulation of SRP and NH_4-N within the hypolimnion of the main basin of the lake was used to independently estimate nutrient flux from the sediments; good agreement was found between core-flux and hypolimnetic mass balance methods.

Given the limited watershed runoff of 2001-2002, internal processes (nutrient recycling and resuspension) were the dominant source of nutrients to the lake over the study period. More recently, Canyon Lake received substantial runoff inputs from the watershed in 2004-05. Under such hydrologic conditions, runoff is expected to be a more significant source of nutrients to the lake.

External loading can thus dominate water quality conditions during the cool rainy season and into the spring and summer, although these nutrients may be recycled a number of times, thus contributing to internal nutrient loading. Internal recycling of nutrients can thus dominate water quality through much of the year, especially during drought conditions. For example, external loading of phosphorus was estimated at only about 4% of the loading due to internal recycling in 2001-2002 (Anderson and Oza, 2003). Similarly, external loading of N was only about 6% of the input from internal nutrient recycling from the sediments.

It is important, then, to understand internal recycling rates and the factors influencing those rates. Previous studies indicate that internal recycling is a complex function of temperature, local dissolved oxygen concentrations, sediment properties and overall lake water quality. This report summarizes results from a study conducted from June 2006 – April 2007 that (i) quantified nutrient release from sediments in the lake, (ii) determined sediment and water oxygen demand, and (iii) evaluated the suitability and effectiveness of different in-lake nutrient control strategies.

Approach

Water column and sediment measurements were made at 5 sites in Canyon Lake (Fig. 1). Two of these sites were included in the assessment conducted in 2001-02, and thus allow direct comparison of internal recycling rates and other properties as found during a drought, 2001-02 (Anderson and Oza, 2003) with those in place following a high runoff year such as found in 2005 (this study). Measurements were also conducted to assess alternative in-lake treatment technologies for improving water quality in Canyon Lake. Based upon previous investigations, 3 alternatives were evaluated in lab studies: (i) aeration, (ii) hypolimnetic oxygenation and (iii) alum application.

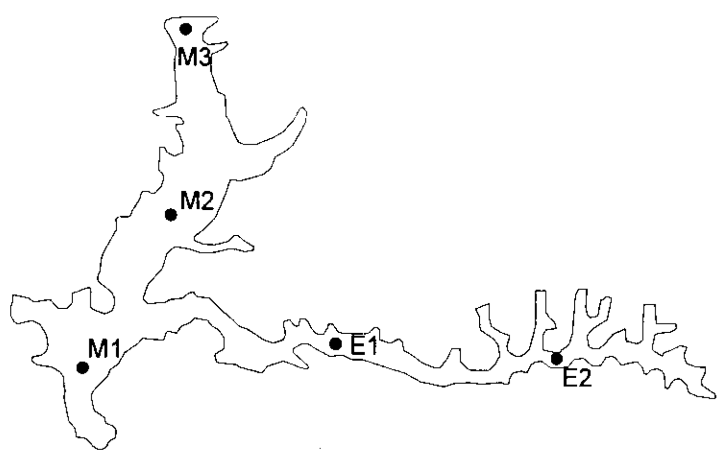

Fig. 1. Study site showing sampling sites in the main basin (M1, M2 and M3) and East Bay (E1 and E2).

(a) Sediment Nutrient Flux and Oxygen Demand

Measurements of sediment nutrient release were conducted in July, September, November and April (2006-07). Sediment oxygen demand was determined on cores collected in the summer (July) and early spring (April). Measurements were made on triplicated intact sediment cores collected from 5 sites (also sampled for water quality) (Fig. 1). As previously noted, nutrient flux measurements were previously made for 2 of these sites, and sediment characterization was completed for all of them (Anderson and Oza, 2003). Moreover, sites M1 and M2 represent relatively deep locations with sediments below the thermocline, and so will remain cool and isolated from the atmosphere during much of the year, while the others are in warm shallow waters. This will provide a clear assessment of the two different environments present in the lake.

Cores were collected following Beutel (2000). An Ekman dredge was used to collect a grab sample, which was then subsampled by carefully inserting a 30.5 cm by 6.3 cm diameter Lucite tube approximately 10 cm into the sediment. The bottom of the core was sealed using a rubber stopper. The core was subsequently carefully topped off with bottom water sampled using a van Dorn sampler, stoppered with zero headspace and transported back to the lab.

Cores were then incubated in the dark at the temperature and DO levels measured at the time of sampling. Approximately 10 mL of water was removed daily, filtered and analyzed for soluble NH_4-N, NO_3-N and SRP using an Alpkem autoanalyzer following standard methods (APHA, 1998). Dissolved oxygen was measured using a YSI Model 55 DO meter, with the water briefly sparged with N_2 or lab air as needed to maintain DO and to very gently mix the water column within the core. The measured change in concentration was used in conjunction with water volume and sediment-water interfacial area to calculate a mass flux rate.

Following the end of the nutrient flux measurements on cores collected in July 2006 and April 2007, cores were sparged with air to approach saturation DO levels, sealed and monitored for loss of DO over time. Separately, water oxygen demand (WOD) was measured on water samples held at appropriate temperatures and analyzed for loss of DO over time. Sediment oxygen demand was calculated from known volumes, sediment surface areas, and rate of DO loss.

(b) Evaluation of In-Lake Treatment Alternatives

The above measurements provide information about the rates of nutrient release and oxygen demand under conditions present in the lake at the time of collection. Separate measurements were also made to assess the capacity of aeration, hypolimnetic oxygenation and alum application to slow the rate of internal loading. The efficacy of dredging at reducing internal loading is presently being evaluated under a separate agreement with Canyon Lake POA.

To evaluate the effectiveness of aeration and oxygenation at controlling nutrient release from sediments, two additional sets of triplicate cores were collected in August 2006 and April 2007 at the 2 deepwater sites (M1 and M2) on the main basin of the lake (Fig. 1). One set of these sediment cores from each site was aerated at the average epilimnetic temperature to simulate aeration achieved with destratification, while the 2nd set was aerated at the hypolimnetic temperature, as would be achieved with hypolimnetic oxygenation (i.e., without destratification). Sediment oxygen demand was also quantified for these cores under these temperature and oxygen conditions.

To assess the suitability of the lake for an alum treatment, jar tests were conducted to evaluate the pH, alkalinity and dissolved Al levels in Canyon Lake water collected on October 9, 2006 prior to and following after additions of 0 – 40 mg/L Al as the aluminum sulfate salt. Separately, alum floc was added to sets of replicate intact cores collected on November 27, 2006 from East Bay (site E2) and the main basin (site M1) to demonstrate control of SRP release from treated sediments. The forms of phosphorus within the sediments were determined using sequential extraction following Lewandowski et al (2003). The extraction results were also used to provide an estimate of the aluminum dose required to inactivate phosphate P within sediments from East Bay and the main basin of the lake (Rydin and Welch, 1999).

Results

Forms of Phosphorus in the Sediments

The sediment in Canyon Lake was found to be dominated by a reducible iron form (Fe-P) that accounted for about 1000 mg/kg or 60% of the average total P recovered by the extractions (Fig. 2). Aluminum-P was 2nd most abundant on average, accounting for 20-25% of the P in sediment from sites M1 and M2, although it constituted a smaller fraction (10.4-12.9%) of the total P recovered by extraction in the other sites. Calcium-P exhibited the largest spatial gradient, with over 400 mg/kg (27%)

of the extracted P from sediments at site E2, while the other, deeper sites ranged from 117-174 mg/kg (7.2-10.7%). The higher Ca-P at site E2 may be due in part to greater local inputs to this site of eroded calcareous soils from the Salt Creek watershed relative to the other sites due simply to proximity to the creek inlet. Labile-P includes SRP in porewater as well as readily-exchangeable forms of P in the sediments and accounted for only about 5% of the extracted P (Fig. 2). Organic-P was also a minor component of the P in the sediments, at concentrations of 39 – 147 mg/kg (2.1 – 7.0% of the P recovered by the extractants) (Fig. 2).

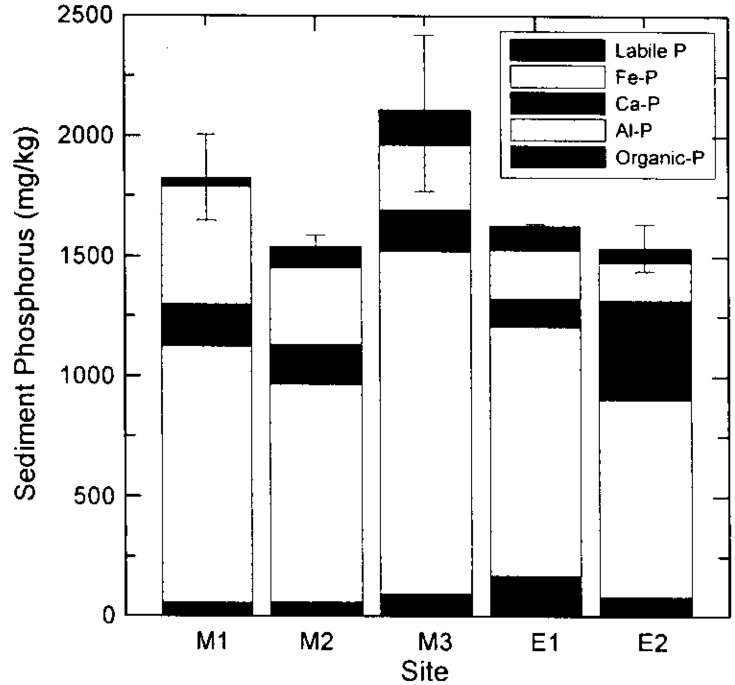

Fig. 2. Forms of phosphorus in sediments recovered using the sequential extraction technique of Lewandowski et al. (2003).

The porewater+exchangeable P (i.e., labile-P) is the most readily available for release to the water column, although Fe-P also serves as a readily available form when anoxic conditions in the hypolimnion and sediments reduce the iron(III) phases retaining the phosphate via specific adsorption and precipitation reactions. Organic-P is also potentially released through mineralization reactions, although it generally considered that such P would partition to Fe, Al or Ca phases upon release from organic matter. The Al-P and Ca-P forms are generally considered to be fixed against release since Al and Ca are not subject to reductive dissolution reactions (in contrast to Fe(III) phases). (The quantity of P in labile+Fe-P forms is often used to estimate alum dose requirements. This will be addressed later in this report.)

The quantity of labile+Fe-P was highest at site M3 (1521 mg/kg) and lowest at site E2 (904 mg/kg); one might anticipate SRP flux to follow this trend, although nutrient flux is a complex function of sediment and water column properties.

Nutrient Release from Sediments

The release of NH_4-N and SRP from sediments varied seasonally as well as across the sites. SRP was released from site E2 at a very high rate through the year (19.6 – 25.7 mg/m^2/d) (Fig. 3). SRP flux was lower and varied more strongly over the year at site E1 (Fig. 3a). While both sites are within East Bay, site E2 is in shallow water (only about 3 m depth) that was well-mixed with generally high DO levels and high temperatures during the summer (e.g., Men and Anderson, 2007). In contrast, site E1 was located in deeper water (~6 m) and just below the thermocline that resulted in cooler summer temperatures with strong anoxia.

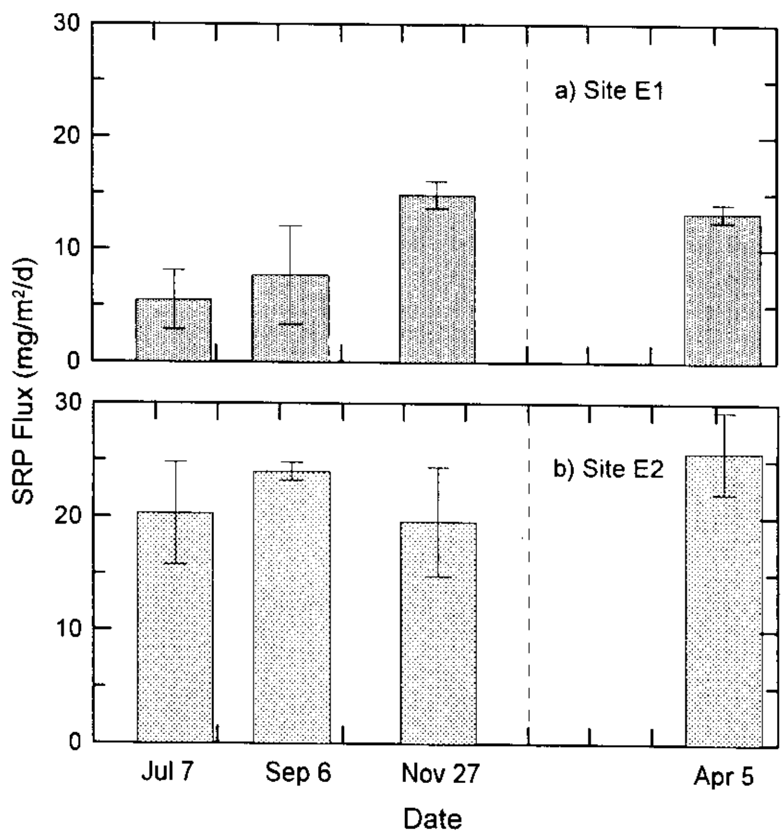

Fig. 3. SRP flux from East Bay sites: a) site E1 and b) site E2.

The rates of SRP flux from the 3 main sites followed the seasonal trends present at site E1, with generally lower rates during the summer and higher rates during winter and early spring (Fig. 4). The consistently highest rate of release occurred from cores collected on April 5th, 2007, with sites M1, M2 and M3 all releasing phosphate at rates exceeding 20 mg/m^2/d (Fig. 4).

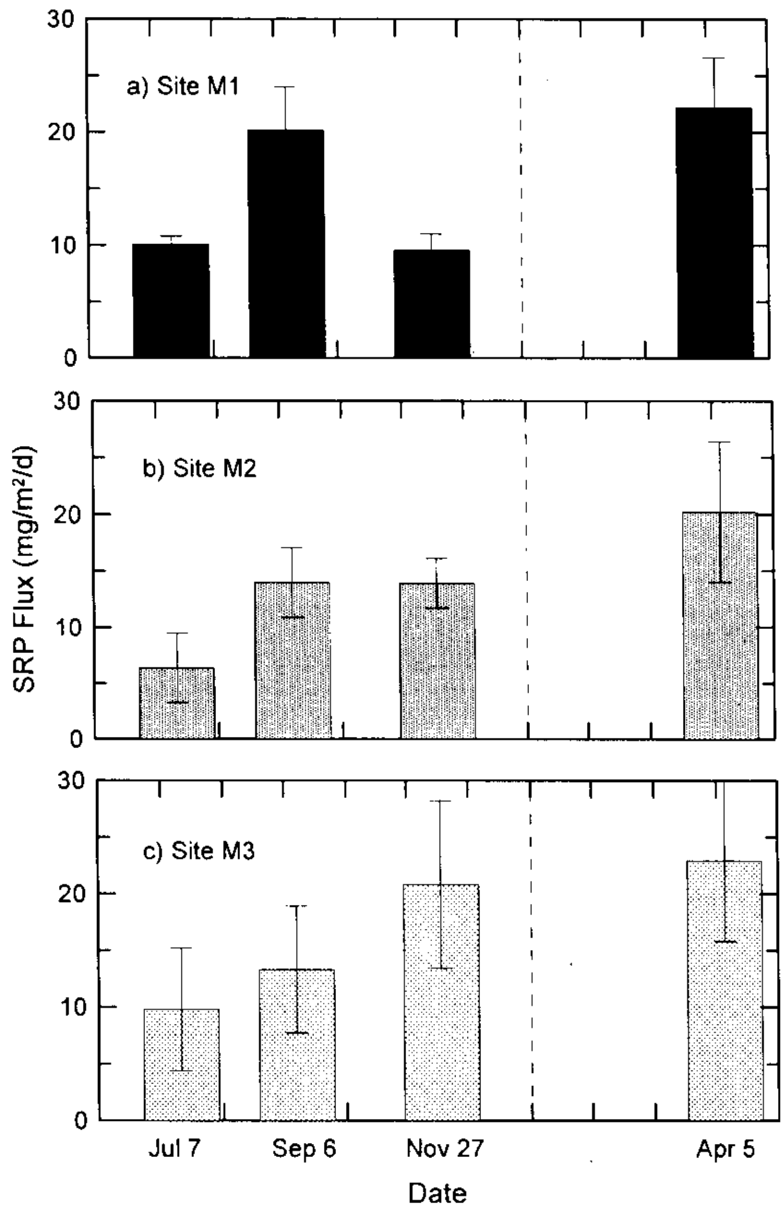

Fig. 4. SRP flux from main basin sites: a) site M1, b) site M2 and c) site M3.

The temperature and DO conditions varied rather little during sampling at sites M1-M3 and E1, however, and were consistently anoxic and cool (12-16 °C) (Table 1), so the seasonal variation in SRP flux appears to be due in more complex ways to the presence and duration of stratification, algal succession and other factors. In contrast, site E2 was consistently warmer on all 4 sampling dates with high levels of DO found in November and April (Table 2). The effects of DO and temperature on SRP flux were explicitly evaluated as part of the in-lake treatment assessment and will be discussed later.

Table 1. Temperature and DO levels during core-flux measurements.

	Sites M1-M3, E1		Site E2	
Date	Temperature (°C)	DO (mg/L)	Temperature (°C)	DO (mg/L)
Jul 7	14	<1	26	>1
Sep 6	14	<1	25	1
Nov 27	16	<2	16	>6
Apr 5	12	<1	12	>4

The flux of NH_4-N from the sediments at site E2 was strongly correlated with temperature, with the lowest flux rate from cores collected in April and incubated at 12 °C, while much higher rates of NH_4-N release were measured during the summer, with rates exceeding 60 mg/m^2/d (Fig. 5). NH_4-N flux rates at the main sites were generally highest following mixing in November and exceeded 80 mg/m^2/d at site M3 (Fig. 6). The average ratio of NH_4-N flux to SRP flux for all sites and dates was 3.2 and reflected the rather strong N-limitations present in Canyon Lake through much of the year (Paez and Anderson, 2007).

These flux rates are generally higher than those found in 2001-2002 (Oza and Anderson, 2003). Two sites from the 2001-2002 study were included in this evaluation (sites M1 and E2). The SRP flux from site M1 increased from an annually-averaged value of 3 mg/m^2/d in 2001-02 to 15.5 mg/m^2/d in 2006-07. Similarly, the rate of SRP release from East Bay sediments increased from 18.8 to 22.4 mg/m^2/d. NH_4-N flux at both sites also increased from values measured in 2001-02 (e.g., from average values of 26.4 and 35.4 mg/m^2/d in 2001-02 to 49.8 and 44.9 mg/m^2/d in 2006-07 at sites M1 and E2, respectively).

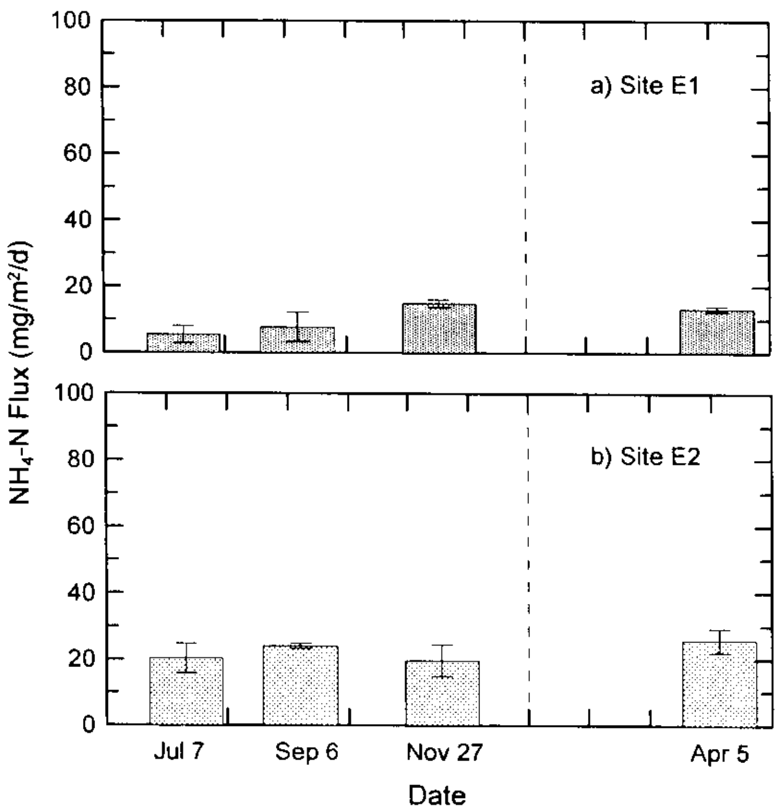

Fig. 5. NH_4-N flux from East Bay sites: a) site E1 and b) site E2.

These findings demonstrate that the sediments act as a long-term source of nutrients in the lake, irrespective of drought conditions (2001-2002) or following a large runoff year (2006-2007), although these results indicate greater internal recycling following large external loading events. In the absence of continued, external loading, burial, conversion of labile forms to less reactive forms, and other reactions slowly reduce the rate of internal recycling.

The average nutrient release rates measured in this study can be compared with those determined for other lakes in the region (Table 2). The average rate of SRP flux from Canyon Lake this past year exceeded, as previously noted, rates measured in Canyon Lake in 2001-2002, as well as rates found in Lake Elsinore and, by a very large margin, the average rate of SRP flux recently determined for Lake Skinner (Table 2). Ammonium-N flux was also up from that measured in 2001-2002 and 5x higher than that determined for Lake Skinner, but below the rate measured in Lake Elsinore (Table 2).

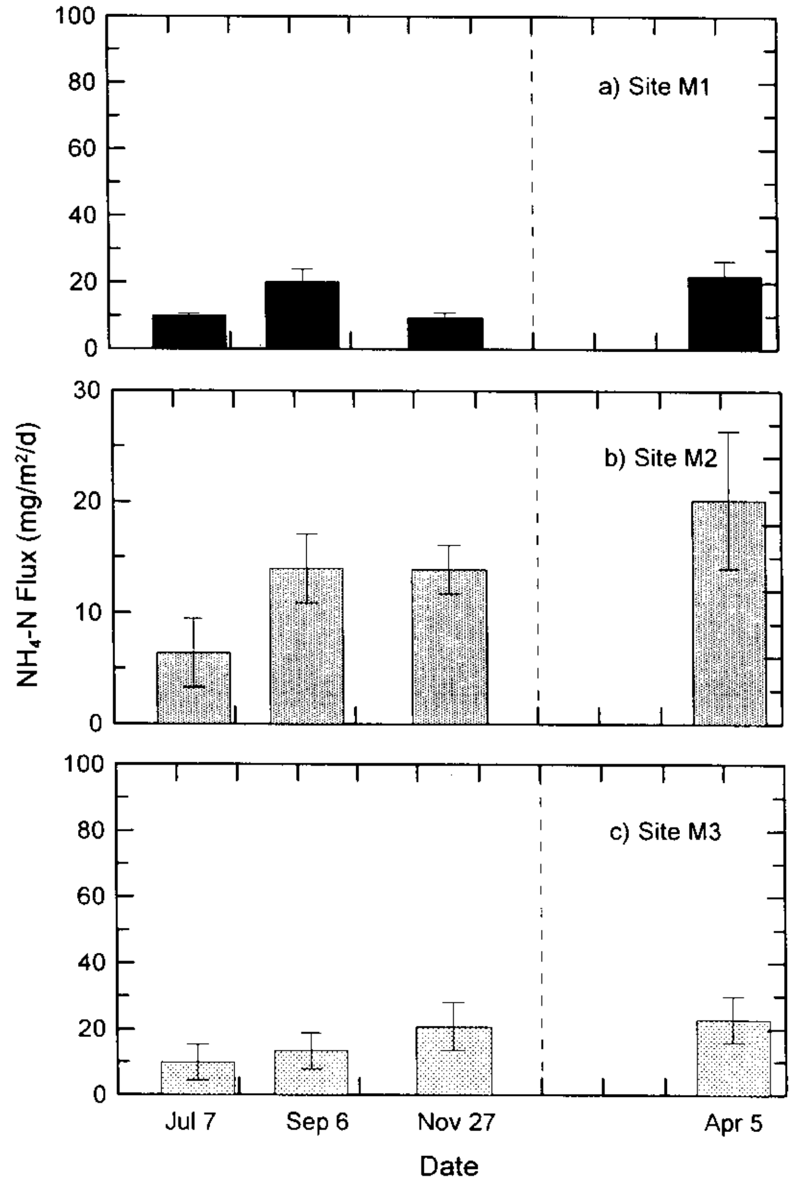

Fig. 6. NH_4-N flux from main basin sites: a) site M1, b) site M2 and c) site M3.

Table 2. Average nutrient flux rates for selected lakes in southern California.				
Flux (mg m^{-2} d^{-1})	Canyon L. (This Study)	Canyon L. (2001-02)	L. Elsinore (2001)	L. Skinner (2007)
SRP	15.7	9.4	9.4	0.5
NH4-N	44.1	28.5	72.2	8.6

This capacity for sediments to serve as a long-term source of nutrients, effectively functioning as a long-term buffer system that can supply nutrients and fuel algal growth for many years, has led to a number of control strategies to inhibit internal recycling. Particular emphasis has been placed on control of phosphorus, since it is the most common limiting nutrient in freshwater systems.

Assessment of In-Lake Treatment Alternatives

Three different approaches to inhibit nutrient release from Canyon Lake sediments were evaluated in this study: alum treatment, aeration and hypolimnetic oxygenation.

a) Alum Treatment

The goal of an alum treatment is to convert labile-P and Fe-P (forming so-called mobile-P) (Fig. 2) into irreversibly sorbed/precipitated Al-P forms. Since Al is not a redox-sensitive element, the $Al(OH)_3$ phase formed following alum addition is stable under both oxic and anoxic conditions; phosphorus is thus retained by Al irrespective of DO conditions near the sediments. This contrasts the Fe(III)-phases in sediments that, while possessing a high capacity for binding phosphate, readily dissolve under low redox conditions thereby releasing SRP back to the water column.

Naturally occurring Al-phases were present in the sediments Canyon Lake sediments and retained 159 – 490 mg/kg P (or 10.4 – 26.8 % of the total recovered by extractions) (Fig. 2). This compared with the 60 – 70% associated with labile+Fe-P forms. Addition of alum drives the conversion to Al-P forms and thus inhibits SRP release from the sediments.

The suitability of an alum treatment for Canyon Lake depends in part upon the chemistry of the lake. Addition of alum results in dissociation of the alum salt:

$$Al_2(SO_4)_3 \bullet 18H_2O \rightarrow 2Al^{3+} + 3SO_4^{2-} + 18H_2O \quad (1)$$

followed by hydrolysis of Al and production of acidity:

$$Al^{3+} + 3H_2O \rightarrow Al(OH)_3 + 3H^+ \quad (2)$$

Thus 3 mols of H^+ are produced for each mol of Al added. Care must be taken to avoid low pH following treatment however, as the solubility and toxicity of Al increases markedly at low pH values.

As a result, the first step in considering an alum treatment is to evaluate the acid-neutralizing capacity (alkalinity) of the lake. Alkalinity in the lake has been measured regularly as part of the monitoring component of our work on the lake. Alkalinity has averaged about 3.4 meq/L across all sites and depths. On that basis, the lake should be able to readily accept an alum dose up to 3 meq/L of Al or 1 mmol/L. Since the atomic weight of Al is 27 g, 1 mmol/L Al is equivalent to 27 mg/L, so an alum dose up to at least 27 mg/L could be added without greatly lowering the pH.

Jar tests were used to more carefully evaluate pH, alkalinity, and dissolved Al levels as a function of alum dose in lake water collected on October 9, 2006. Alkalinity and pH were determined approximately 1 h after alum addition and again 24 h later after vigorous sparging with air to hasten the approach to chemical equilibrium (Anderson, 2004). Samples were also filtered and analyzed for dissolved Al after 24 h.

The pH of the water declined significantly with increased alum dose immediately following treatment, although pH values returned to near pretreatment levels (7.6-8.4) after equilibration (Fig. 7a). This pH shift has been observed in prior laboratory studies and is due to the out-gassing of CO_2 formed from reaction of H^+ with bicarbonate alkalinity (Anderson, 2004).

Correspondingly, alkalinity declined linearly with increasing alum dose (Fig. 7b). Alkalinity was also unchanged over time, with equilibrium values that were generally within 0.05 meq/L of the concentrations determined shortly after alum addition (Fig. 7b). Dissolved Al concentrations after equilibration exhibited maximal concentrations at low alum doses that decreased nonlinearly with increasing dose (Fig 7c) and modestly reduced pH (Fig. 7a) following known pH-solubility relationships for amorphous Al phases (Anderson, 2004). These experimental results confirm that an alum dose up to 30 mg/L as Al will not dramatically alter the equilibrium pH or dissolved Al levels, and in fact a dose up to 40 mg/L may be possible. Higher doses would require use of buffered alum or aluminate.

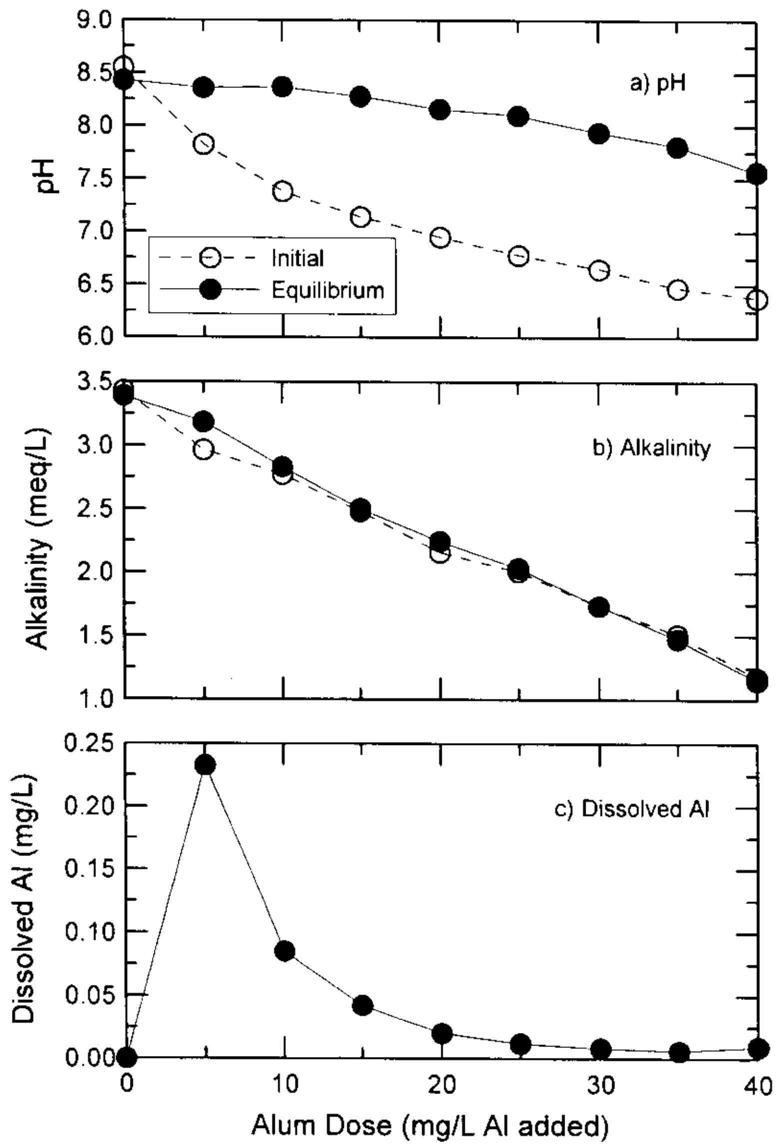

Fig. 7. Jar test results: a) pH, b) alkalinity and c) dissolved Al as function of alum dose.

Alum floc added to cores collected on November 27th at a rate of approximately 20 g Al/m^2 greatly reduced the rate of SRP flux when compared to rates measured from reference cores (i.e., without alum floc added) (Fig. 8). In fact, alum floc *removed* SRP from the water column overlying site M1 cores, resulting in a significant negative flux. While a higher rate of SRP flux from the sediments at site E2 was found, alum also very effectively controlled P release at this site as well, achieving an 85% reduction in SRP flux (Fig. 8). Alum floc added to cores also slowed by 20-70 % the release of NH_4-N from sediments collected at these sites (data not shown). Although NH_4^+ is not thought to interact strongly with alum floc, some additional cation exchange capacity, combined with greater impedance to diffusive flux, is thought to have altered the rate of ammonium flux in these cores.

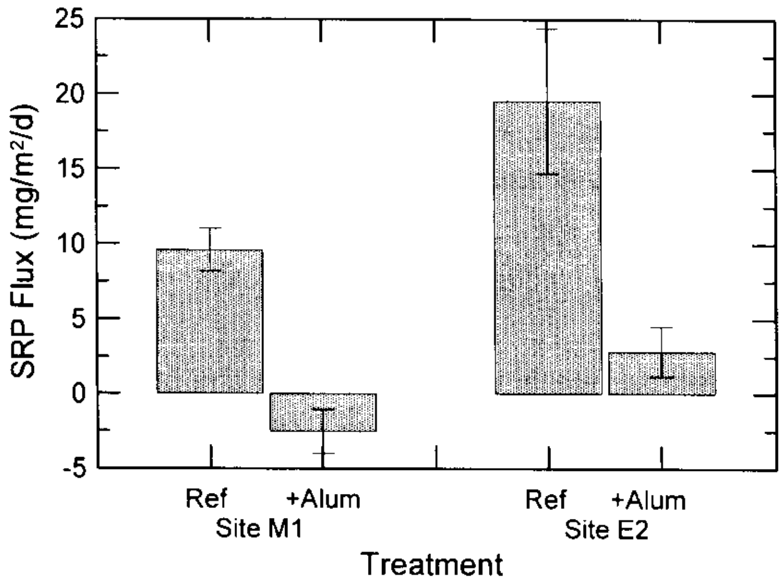

Fig. 8. Effect of alum floc on SRP flux from sediment cores.

The amount of alum needed to inactivate the potentially mobile P in the sediments can be estimated alternately from extraction results (Fig. 2) as well as measured SRP flux rates (Figs. 3-4).

As previously noted, mobile-P is generally taken as labile-P+Fe-P (Rydin and Welch, 1999). Mobile-P concentrations ranged from 904 – 1521 mg/kg and averaged 1144 mg/kg over the 5 sites (Fig. 2). For this calculation, we will ignore site to site differences and use the average mobile P concentration. The total amount of mobile-P to be inactivated is a function of the assumed depth of active exchange with the water column and the mass of sediment per unit volume of wet sediment (water+sediment). From prior work on sediments, approximately 90% of the wet sediment volume is typically present as water. The remaining 10% of the sediment volume exists as solids; the density of the sediment solids can vary from about 1.0 g/cm^3 for organic matter to 2.6 g/cm^3 for SiO_2. For these calculations, it was assumed that the particle density was 2.0 g/cm^3 to reflect the modest organic matter contents in the sediments (Anderson and Oza, 2003). Further assuming a 10-cm reactive zone and using a target of 10:1 added Al to mobile P (Rydin and Welch, 1999), the average alum dose to inactivate the mobile-P in the sediments is estimated at 229 g Al/m^2.

For comparison, one can estimate the alum dose required to inactivate P based upon SRP flux measurements. The annual average SRP flux for the 5 sites varied from 10.4 – 22.4 mg/m^2/d, with a mean value across the 5 sites of 15.7±4.4 mg/m^2/d. The required alum dose is a function of the anticipated longevity of the treatment. While alum has been shown to be effective for 10-15 yrs, given the hydrology of the region and the potential for periodic large external loading events, we will assume a desired 5-yr treatment effectiveness. Thus, the product of the annual average internal loading rate, treatment duration, and a 10:1 added Al to mobile-P ratio, one calculates a required alum dose of 287 g Al/m^2.

These two estimates are in reasonable accord and point to a very high alum application rate. For comparison, the Al dose applied to Big Bear Lake in 2004 was 29 g Al/m^2.

To reach these dose rates will require adding a significant of alum that may yield quite high concentrations in the lake, especially in East Bay and other shallow areas of the lake if treated. The local concentration of Al in g/m^3 (or equivalently, mg/L) can be readily calculated from the Al dose rate (e.g., 229 g Al/m^2) divided by the depth (m). Thus, treatment of much of East Bay with depths of about 3 m (e.g., near site E2) to the mobile-P based dose of 229 g Al/m^2 would require addition to an average concentration of 76 mg/L Al. Importantly, this far exceeds the water's alkalinity and natural capacity to neutralize the acidity generated from alum hydrolysis, and so would require use of buffered alum to maintain appropriate pH values there. The depth-averaged Al concentration would be lower in the main portion of the lake however (e.g., 18 mg/L at site M1 that has a depth of approximately 13 m). This lower treatment concentration is within the lake's natural capacity to buffer against strong reduction in pH, so regular liquid alum could be at the deep-water regions.

b) Aeration

The effects of aeration on nutrient release from sediments were evaluated by comparing flux rates from natural and aerated sediment cores collected on September 20, 2006 and April 5, 2007 from sites M1 and M2. Sites M1 and M2 represent the 2 deepest sites in this assessment and thus are subject strong summer stratification. One set of triplicate cores from each site was incubated at the temperature and DO conditions present at the time of sampling (flux rates previously described), while a 2nd set of cores were vigorously sparged with air. Samples were filtered and analyzed for SRP and NH_4-N as previously described.

The flux of SRP was reduced an average of 37% (excluding the apparent increase in flux at site M2 from the September 2006 assay) (Table 3). Since aeration would destratify the water column, the aerated cores were incubated at warmer temperatures (21-25 °C) than the reference cores, which were held at 12-15 °C. This, combined with potentially insufficient airflow, may account for the elevated SRP flux relative to the M2 reference cores. Since this feature was not found when repeated in April 2007, this observation was excluded from the calculation of the average % reduction in SRP flux. Careful inspection of the cores from April 2007 confirmed continual vigorous airflow and development of a light brown oxidized layer on the surface of the sediments. Despite strongly aerobic conditions, SRP flux was observed to continue, albeit at a slower pace. A reduction in SRP flux of 35-40% is consistent with results from similar measurements made on Lake Elsinore sediments.

Table 3. Effect of aeration on nutrient release from sediments.

	M1		M2		Average % Reduction
	Reference	+Aeration	Reference	+Aeration	
SRP Flux					
Sep 2006	14.0±1.4	9.3±3.1	8.7±1.2	12.7±1.5[a]	37%
Apr 2007	22.2±4.4	13.9±4.8	20.2±6.2	12.1±6.4	
NH_4-N Flux					
Sep 2006	71.3±4.1	98.3±46.4	27.0±4.6	71.3±34.7	Variable
Apr 2007	41.2±2.6	-36.6±0.1	21.2±0.8	-19.4±9.6	

The flux of NH_4-N exhibited different behavior in cores collected in September 2006 with those collected in April 2007 (Table 3). The measurements from the fall indicated an increase in NH_4-N flux, presumably due to the higher temperatures. Seasonal trends support the role that higher temperatures can play on rates of NH_4-N flux. Measurements repeated in April 2007 found a net loss of NH_4-N from the water column, however, indicating not only a reduction in NH_4-N flux but also a reversal in the direction of flux. That is, under vigorous aeration at approximately 22 °C, NH_4-N concentrations in the water overlying the sediments actually declined. Specifically, the concentrations increased slightly over the 1st day, but declined rapidly after 1-2 days. Apparently 1-2 days were necessary to establish nitrifying conditions in the cores, although nitrate concentrations were not explicitly quantified in these samples.

c) Hypolimnetic Oxygenation

The effect of hypolimnetic oxygenation on nutrient flux was simulated in laboratory studies by sparging water overlying replicate cores with air while maintaining the temperature at that of the hypolimnion present at the time of sampling. Thus, both the sets of reference cores as well as the sets of oxygenated cores were maintained at the same temperatures (15 and 12 °C for the September and April tests, respectively). DO concentrations remained >8 mg/L in the oxygenated cores while levels declined to <1 mg/L in the untreated (reference) cores.

A large variation in the effect of hypolimnetic oxygenation on SRP flux was found in the September 2006 tests, with essentially no SRP flux out of the sediments at site M2, while only a modest effect on flux from site M1 was found (Table 4). These tests were repeated in April and confirmed the very dramatic reduction in SRP flux at site M2. A more dramatic reduction was also found for site M1 as well (Table 4). It appears there may be sufficient geochemical differences present at the 2 sites to yield large spatial differences. Notwithstanding, averaged over both sites and dates, hypolimnetic oxygenation was found to lower SRP flux by 71%.

The flux of NH_4-N was more variably affected than SRP, although flux rates were lowered by an average of 35% across all tests. The source of the variability remains unclear, but differences over time and space in the types and concentrations of algal/detrital organic matter, bacterial population dynamics, and other factors no doubt play some role. Unlike aeration, we did not find evidence for nitrification over the modest duration of the core-flux studies simulating hypolimnetic oxygenation, although that is probably a result of the cooler temperatures (12°C vs. 21 °C). The cooler temperatures presumably slowed the development of a robust community of nitrifying bacteria when compared with the warm conditions in the aerated cores; it is expected that such a community would develop in a relatively short period of time and reduce NH_4-N flux to extents exceeding that in Table 4.

Table 4. Effect of oxygenation on nutrient release from sediments.

	M1		M2		Average % Reduction
	Control	+Oxygenation	Control	+Oxygenation	
SRP Flux					
Sep 2006	14.0±1.4	12.0±4.4	8.7±1.2	-0.1±2.2	71%
Apr 2007	22.2±4.4	5.4±5.0	20.2±6.2	1.1±1.6	
NH_4-N Flux					
Sep 2006	71.3±4.1	60.3±11.8	27.0±4.6	3.7±13.7	35%
Apr 2007	41.2±2.6	17.5±1.8	21.2±0.8	25.2±6.0	

Sediment Oxygen Demand

Both aeration and hypolimnetic oxygenation must supply DO at a rate sufficient to meet sediment oxygen demand (SOD). In the above tests, excess O_2 was provided to ensure that SOD was met and aerobic conditions were maintained at the sediment-water interface. Because of the electrical costs to operate compressors to drive a diffused aeration system, and the costs of oxygen in hypolimnetic oxygenation systems, it is prudent to have an estimate of the oxygen demand that must be met to maintain the sediment-water interface in an aerobic condition. Measurements were conducted on 2 dates to quantify the SOD in the lake.

In the initial assessment, SOD from all 5 sites was quantified on cores collected on July 11th, 2006. Mean SOD values from triplicate cores were quite similar across the 5 sites and averaged slightly less than 300 mg/m^2/d (Fig. 9), a rate lower than previously found for Lake Elsinore (~1,000 mg/m^2/d) and more recently for the Salton Sea (2,100-2,400 mg/m^2/d) (Anderson, unpubl. data).

In follow-up measurements made on cores collected from sites M1 and M2 on April 5, 2007, both short-term and longer-term SOD rates were determined. Short-term SOD was specifically evaluated for cores held at 12 °C and not previously aerated to simulate the demand shortly after start-up of a hypolimnetic oxygenation system, while longer-term demand was measured on cores that had been continuously sparged at hypolimnetic temperatures (12 °C) for the preceding 6 days. Short-term SOD at the 2 deepest sampling sites was somewhat higher than found in the preceding summer, with SOD slightly lower at site M2 compared with site M1 (Table 5).

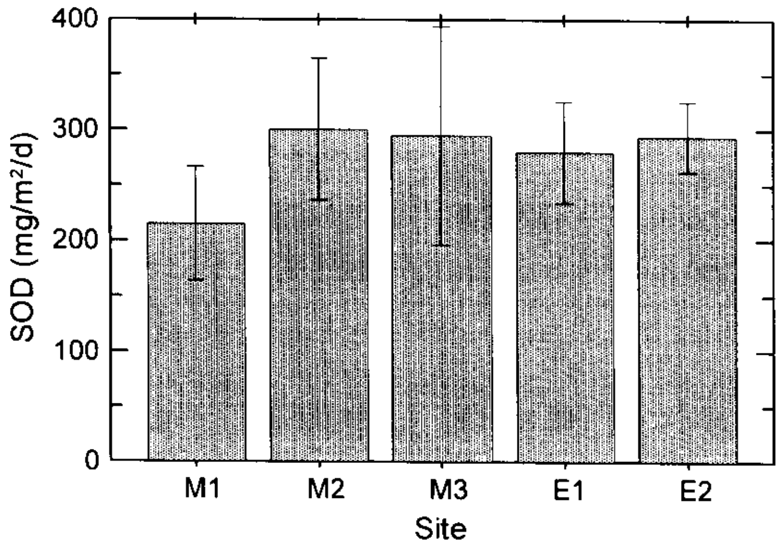

Fig. 9. Sediment oxygen demand measured on cores collected on July 11, 2006.

Prior sparging of the water column at hypolimnetic temperatures lowered the SOD rate by more than 1/3rd or 130-140 $mg/m^2/d$ at the 2 sites due to the oxidation of sulfide, Fe^{2+} and Mn^{2+} in the surface sediments. Further reductions in SOD may be witnessed under protracted oxygenation as reducing power of the sediments is offset by the diffusive flux of DO into the sediments.

Table 5. Sediment oxygen demand (SOD) at sites M1 and M2: April 2007.

Core Site	Hypolimnetic Oxygenation (12 °C)		Aeration (21°C)
	Short-term SOD ($mg/m^2/d$)	*Long-term SOD ($mg/m^2/d$)*	*Long-term SOD ($mg/m^2/d$)*
M1	383 ± 23	251 ± 28	471 ± 14
M2	361 ± 17	221 ± 49	312 ± 20

Long-term demand under higher temperatures (21 °C in this experiment), as would be present during aeration that would destratify the main basin of the lake, was greater than SOD values measured at cooler temperatures present during hypolimnetic oxygenation (12 °C here). This is consistent with the increased rates of biological and chemical reactions with increasing temperature. The SOD was also greater at site M1 than M2, as found in the other SOD measurements, although the disparity was greater at 21 °C than 12 °C (Table 5).

With some assumptions about the area of sediments below the thermocline, one can make a provisional estimate the total O_2 needed to maintain oxic conditions near the sediments. Based upon lake bathymetry and water column profile measurements, we will assume about 140 acres of sediments lay below the thermocline and therefore will consume O_2 supplied by a hypolimnetic oxygenation system. Further assuming a long-term SOD rate of approximately 230 mg/m^2/d, the daily O_2 requirement would be a modest 130 kg O_2/d. Further assuming stratification is in place from March 15th – November 15th (245 days) and that the SOD rate remains unchanged with prolonged oxygenation, the total O_2 that must be supplied would be 31,850 kg. Additional O_2 would be needed to offset consumption due to biological respiration reactions in the water column. Water-oxygen demand (WOD) was measured at 1.8 mg/L/d in hypolimnetic water in the July experiment, although this included DO used to oxidize free sulfide, Fe^{2+} and other reduced chemical species, and so does not represent a realistic long-term WOD in a well-oxygenated water. The BOD measured on March 22nd, shortly before sampling the cores in April, averaged 2.7 mg/L for the M1 and M2 sites, so using this value and the duration of the test (5-days), yields what is likely to be a more accurate WOD for the lake (about 0.5 mg/L/d). With an average hypolimnetic thickness somewhere near 5 m, the contribution of the water column is thought to be broadly comparable to the demand exerted by the sediments, so the total oxygen demand is expect to be closer to 250 kg O_2/d.

Cost Estimates for In-Lake Treatment Alternatives

Cost estimates for the 3 in-lake treatment alternatives were taken from previous reports (Fast, 2002; Horne, 2001) or other documentation (BBMWD, 2004). Alum application to 200 acres of sediments (most of the main basin and East Bay) at the full recommended dose of 229 g Al/m^2 based upon the average mobile-P in the sediments is projected to cost \$ 1.1M assuming a cost of \$1.30/gal liquid alum (Table 6). The treatment would represent a one-time application and thus a one-time cost, so no annual operating costs are associated with such a treatment. The estimated capital costs for the diffused aeration and hypolimnetic oxygenation systems are both somewhere near \$250K and substantially lower than that for a full alum treatment (Table 6). Unlike alum, however, these systems would have significant annual operating costs, estimated to be on the order of \$20K-50K and associated with electrical costs (diffused aeration) and liquid oxygen (hypolimnetic oxygenation).

Table 6. Estimated costs for the 3 in-lake treatment alternatives. (Sources: [a]BBMWD; [b]Fast, 2002; [c]Horne, 2001).

Costs	Alum[a]	Diffused Aeration[b]	Hypolimnetic Oyxgenation[c]
Capital Costs	\$ 1.1 M	\$ 250K	\$ 200K - \$ 500K
Operating Costs (yr^{-1})	\$ 0	\$ 30K	\$ 20K - \$ 50K

These costs can also be normalized to unit mass of nutrient removed. For this analysis, we will focus on SRP flux, since it was previously noted that alum would be expected to have little long-term direct effect on nitrogen release. Assuming a nutrient source area of approximately 200 acres that releases an average of 15.7 mg SRP/m^2/d, and a 10 yr project period, one estimates that 46,380 kg of SRP. Based upon SRP flux reductions determined in this study for alum, diffused aeration and hypolimnetic oxygenation (85, 37 and 71%, respectively), one can infer unit costs per kg SRP removal of \$27.9/kg SRP for alum, \$32.1/kg SRP for diffused aeration, and \$12.1-\$30.4/kg SRP for hypolimnetic oxygenation. While it is difficult to conduct a similar analysis for N, aeration and oxygenation are also expected to offer greater overall control for N than alum. Based upon this analysis then, hypolimnetic oxygenation offers the lowest cost for nutrient control.

Recommendations and Conclusions

Internal recycling represents a substantial source of nutrients to the water column of Canyon Lake. A nutrient budget developed for 2001-02 indicated that >90% of the nitrogen and phosphorus loading to the lake was due to internal recycling. While a nutrient budget was not developed in this study, the very low precipitation and runoff this past winter, combined with high rates of internal loading (rates that were, in fact, higher than measured in 2001-02), certainly make internal processes once again the dominant source of nutrients to Canyon Lake. Moreover, the higher rates of N and P release from the sediments measured this year suggest that internal recycling rates increase following large external loading events (e.g., 2005).

Laboratory studies indicate that alum treatment, aeration and hypolimnetic oxygenation would all help slow the rate of nutrient release and improve water quality in the lake. Based upon our laboratory measurements, alum was the most effective at controlling internal loading of SRP, reducing by 85% or more SRP flux from the sediments. Hypolimnetic oxygenation was 2nd most effective, and achieved an average reduction in SRP flux of 71%, while aeration was the least effective, yielding an average reduction in internal loading of SRP by 37%. The effect of these different in-lake treatments on NH_4-N release was more variable and thus makes it difficult to draw firm conclusions. On average, alum and hypolimnetic oxygenation had broadly similar effects on NH_4-N flux, achieving short-term average reductions of 35-45%. The effect of aeration varied dramatically, with comparatively weak aeration hastening the release of NH_4-N, although more intense aeration resulted in nitrification and strong removal of NH_4-N from the waters overlying the cores. Overall, however, sufficient evidence exists in the literature to indicate that maintenance of an adequate concentration of DO, either through hypolimnetic oxygenation or aeration, would limit NH_4-N release and promote active nitrification in the surficial sediments (Wetzel, 2001). The cooler temperatures associated with hypolimnetic oxygenation should slow the overall rate of N release compared with aeration, however.

Thus, while all 3 techniques have some merit, *hypolimnetic oxygenation* in our view offers the greatest overall potential for reliably and cost-effectively improving water quality in Canyon Lake. It was demonstrated to substantially lower the rate of internal recycling of SRP and also slow sediment release of NH_4-N, with the capacity to achieve even greater reductions in NH_4-N flux over a longer period of time than used in our studies. The conversion of NH_4-N to NO_3-N should also foster denitrification reactions and thus provide a mechanism for the net removal of N from the system. Alum is unlikely to achieve this. This is an important consideration since Canyon Lake often exhibits strong N-limitations. That is, simultaneous control of both P and N should have a greater beneficial effect on water quality than just P control likely to be achieved with alum. Concern also exists about watershed inputs overwhelming an alum treatment and rendering it ineffectual in controlling subsequent SRP flux. Finally, alum will not provide any control on the release and accumulation of H_2S, Fe^{2+} and Mn^{2+} in the water column. These constituents make the hypolimnetic water unsuitable for routine use as a raw drinking water supply. Hypolimnetic oxygenation would dramatically improve water quality from this perspective as well. Aeration was found to be less effective than hypolimnetic oxygenation at controlling SRP flux and also necessarily destratifies the lake. Maintenance of stratification is viewed as highly desirable, since stratification limits the migration of any nutrients released from the deepwater sediments to the photic zone and, if adequately oxygenated, also provides a cool-water habitat that should provide for a richer and more diverse fishery as well as a daytime refuge for *Daphnia* and other zooplankton in the lake.

Acknowledgments

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Proposal Title: Predicted Effects of In-Lake Treatment on Water Quality in Canyon Lake

Submitted By: Michael Anderson

Submitted To: Lake Elsinore-San Jacinto Watersheds Authority

Date: 21 September 2007

A modeling analysis is proposed to predict effects of aeration, hypolimnetic oxygenation and alum treatments on the water quality in Canyon Lake. Predicted dissolved oxygen (DO), nutrient and chlorophyll concentrations will be compared with numeric targets identified in the nutrient TMDL for the lake. The 1-D linked hydrodynamic-ecological model DYRESM-CAEDYM will be used in this assessment. DYRESM has been used in 59 countries for numerous types of water quality applications and has undergone continual testing and development over the past decade (CWR, 2006). The model will be calibrated using water column and sediment nutrient flux data collected over the past year (Anderson et al., 2007) to reproduce the 2006-2007seasonal trends in temperature and DO profiles, chlorophyll and nutrient concentrations, as well as time of fall mixing and start of spring stratification. The model has a diffused-aeration module that will be implemented to evaluate what effect operation of such a system would have on DO levels, stratification, nutrients and chlorophyll. Hypolimnetic oxygenation will be simulated through addition of a small volume of very high DO water into the hypolimnion. An alum treatment will be simulated through reduction of internal loading rates for phosphorus. Simulations will be conducted for three hydrological conditions, representing years with (i) limited runoff and minimal external loading to the lake, (ii) an average runoff condition, and (iii) an El Nino-type condition with large amounts of rainfall, runoff and external loading of nutrients to Canyon Lake.

Reporting

A draft final report will be submitted to LESJWA by December 10th and a final report based upon feedback from the Technical Advisory Committee and others will be submitted by December 31st, 2007. Electronic copies of input files and simulation results will also be provided.

Schedule

	October November December
Model parameterization	XXXX
Model calibration to 2006-07 data	XXXXXX
Simulations of in-lake treatments	XXXXXX
Draft Final Report	XXXX
Final Report	XX

Budget

The projected cost for the parameterization and calibration of the model, model simulations and development of draft and final reports is $18,000.

References

Anderson, M.A, C Paez and S. Men. 2007 Sediment Nutrient Flux and Oxygen Demand Study for Canyon Lake with Assessment of In-Lake Alternatives. Final Report submitted to the San Jacinto Watershed Council. 24 pp.

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Attachment E.

Update of Watershed and In-Lake Nutrient Models

Lake Elsinore & San Jacinto Watersheds Authority

City of Lake Elsinore • City of Canyon Lake • County of Riverside
Elsinore Valley Municipal Water District • Santa Ana Watershed Project Authority

October 31, 2007

Hope Smythe
Regional Water Quality Control Board
3737 Main St., Suite 500
Riverside, CA 92501

RE: Lake Elsinore and Canyon Lake Nutrient TMDL Task Deliverable
Task 11 - Update to Watershed and In-lake Nutrient Models Plan

Dear Ms. Smythe:

The Basin Plan Amendment requires, no later than March 31, 2007, that stakeholders of the Lake Elsinore and Canyon Lake Nutrient TMDL Task Force[1] (Task Force) submit to the Regional Board for approval a proposed plan and schedule for updating the existing Lake Elsinore/San Jacinto River Nutrient Watershed Model and the Canyon Lake and Lake Elsinore in-lake models.

This plan, as required by Resolution No. R8-2004-0037, considers additional data and information that are generated from the respective TMDL monitoring programs, as well as, the Regional Board's triennial review schedule in order to facilitate any needed update of the numeric targets and/or the MDLs/WLAs/Las.

On April 30, 2007, LESJWA requested and was granted an extension out to March 31, 2009 to allow for the collection of additional watershed and lake data and to allow ongoing and planned lake biomanipulation projects to proceed. This extension, however was later rescinded after further examination of the guidelines for requesting revisions to the Basin Plan.

Therefore, LESJWA on behalf of the members of the Task Force stakeholders have prepared the following plan and schedule (Table 1) to outline the steps necessary to complete this task.

To support this effort, stakeholders are currently implementing a comprehensive nutrient monitoring program, "The Lake Elsinore and Canyon Lake Nutrient TMDL Monitoring Plan". This plan approved by the Regional Board in March 2006 (Resolution No. R8-2006-0031), in addition to tracking compliance with the TMDL load allocations, and measuring compliance to in-lake numeric water quality targets will address a number of data gaps and limitations necessary to update the Watershed and In-lake Nutrient Models.

[1] Lake Elsinore / Canyon Lake TMDL Task Force members include: the County of Riverside, the City of Beaumont, the City of Canyon Lake, the City of Hemet, the City of Lake Elsinore, the City of Moreno Valley, the City of Murrieta, the City of Perris, the City of Riverside, the City of San Jacinto, Riverside County Flood Control and Water Conservation District, Elsinore Valley Municipal Water District, Western Riverside County Agricultural Coalition acting on behalf of the Agricultural Operators and Dairy Operators in the San Jacinto River Basin, the California Department of Transportation (CalTrans), the California Department of Fish and Game, Eastern Municipal Water District, the U.S. Forest Service in the U.S. Department of Agriculture, March Air Reserve Base Joint Powers Authority and the U.S. Air Force. Task Force organization and activities are coordinated by the Santa Ana Watershed Project Authority (SAWPA).

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In the RWQCB approved monitoring plan, a phased approach is described which will all the gathering of data first on the lakes and then on the watershed runoff. Under Phase 1, water quality data will be collected regarding in-lake processes and the "linkage analysis" relating external pollutant loading to in-lake response and the associated predicted nutrient concentrations compared to numeric water quality targets. Due to the intricacies involved with this process, the Phase 1 is scheduled to occur over (2-3) years depending on the completion of in-lake studies and the amount of data collected under Phase 1. Phase 2 will commence after Phase I and will include the incorporation of additional TMDL and flow monitoring stations to assist in addressing watershed data gaps. Completion of Phase 2 of the approved monitoring program will enable the prediction of more reliable internal and external watershed loading via the update of historical models.

Table 1: Update Watershed and In-Lake Nutrient Models - Implementation Schedule

	IMPLEMENTATION ACTION	RESPONSIBLE PARTY	ESTIMATED COMPLETION DATE
1	Complete Study of In-Lake Processes	Stakeholder Task Force	Dec 2008
2	Complete Study of Linkage Analysis Related to External Loading	Stakeholder Task Force	Dec 2009
3	Complete Study of External Nutrient Source Contributions	Stakeholder Task Force	Aug 2010
	a. Agricultural Dischargers Data	Agricultural Operators	
	b. On-Site Disposal Systems Data	Urban Dischargers	
	c. Urban Dischargers Data	Urban Dischargers	
	d. Forest Service Data	U.S. Forest Service	
4	Define Modeling Goals and Objectives	Stakeholder Task Force	Nov 2010
5	Evaluate Available Models	Stakeholder Task Force	Dec 2010
6	Obtain Update of SCAG Land Use Coverage	Stakeholder Task Force	Dec 2010
7	Design Lake and Watershed Modeling Framework	Stakeholder Task Force	Mar 2011
8	Construct and Calibrate Models	Stakeholder Task Force	Jun 2011
9	Perform Modeling Scenarios	Stakeholder Task Force	Aug 2011
10	Modeling Recommendations and Final Report	Stakeholder Task Force	Nov 2011

Table 1 Data is subject to change according to available data and adaptive management changes.

Thank you for your consideration. If you have any questions or concerns regarding our proposed plan, please contact me at 951-354-4221.

Respectfully submitted,

Mark Norton

Mark Norton P.E.
LE/CL TMDL Task Force Administrator

Attachment F.

Pollutant Trading Plan

Lake Elsinore & San Jacinto Watersheds Authority

City of Lake Elsinore • City of Canyon Lake • County of Riverside
Elsinore Valley Municipal Water District • Santa Ana Watershed Project Authority

October 31, 2007

Hope Smythe
Regional Water Quality Control Board
3737 Main St., Suite 500
Riverside, CA 92501

RE: Lake Elsinore and Canyon Lake Nutrient TMDL Task Deliverable
Task 12 - Pollutant Trading Plan

Dear Ms. Smythe:

The Basin Plan Amendment requires, no later than September 30, 2007, that stakeholders of the Lake Elsinore and Canyon Lake Nutrient TMDL Task Force[1] (Task Force) submit a proposed "Pollutant Trading Plan" (Task #12).

This plan, as required by Resolution No. R8-2004-0037, shall contain a schedule and funding strategy for project implementation, an approach for tracking pollutant credits, as well as, a schedule for reporting status of implementation of the Pollutant Trading Plan to the Regional Board. LESJWA on behalf of the members of the Task Force stakeholders have prepared the following plan and schedule (Table 1) to outline the steps necessary to complete this task.

On April 30, 2007, LESJWA requested and was granted an extension out to March 31, 2009 to allow for the collection of additional watershed and lake data and to allow ongoing and planned lake biomanipulation projects to proceed. This extension, however was later rescinded after further examination of the guidelines for requesting revisions to the Basin Plan.

To support the development of the Pollutant Trading plan, stakeholders are currently implementing a comprehensive nutrient monitoring program, "The Lake Elsinore and Canyon Lake Nutrient TMDL Monitoring Plan". This plan approved by the Regional Board in March 2006 (Resolution No. R8-2006-0031), in addition to tracking compliance with the TMDL load allocations, and measuring compliance to in-lake numeric water quality targets will address a number of data gaps and limitations necessary to implement pollutant trading. Upon implementation of the first two phases of water quality monitoring for the lakes and watershed

[1] Lake Elsinore / Canyon Lake TMDL Task Force members include: the County of Riverside, the City of Beaumont, the City of Canyon Lake, the City of Hemet, the City of Lake Elsinore, the City of Moreno Valley, the City of Murrieta, the City of Perris, the City of Riverside, the City of San Jacinto, Riverside County Flood Control and Water Conservation District, Elsinore Valley Municipal Water District, Western Riverside County Agricultural Coalition acting on behalf of the Agricultural Operators and Dairy Operators in the San Jacinto River Basin, the California Department of Transportation (CalTrans), the California Department of Fish and Game, Eastern Municipal Water District, the U.S. Forest Service in the U.S. Department of Agriculture, March Air Reserve Base Joint Powers Authority and the U.S. Air Force. Task Force organization and activities are coordinated by the Santa Ana Watershed Project Authority (SAWPA).

runoff, model updates will be performed on the watershed model and the lake models. This will improve the accuracy of allocation of sources of nutrients impacting the lakes. Understanding these sources will provide better understanding of corrective implementation and pollutant trading opportunities.

Table 1: Pollutant Trading Plan - Implementation Schedule

	IMPLEMENTATION ACTION	RESPONSIBLE PARTY	ESTIMATED COMPLETION DATE
1	Complete Phase 2 Water Quality Monitoring	Stakeholder Task Force	Aug 2010
2	Complete Model Updates	Stakeholder Task Force	Nov 2011
3	Conduct Feasibility Analysis and Identify Pollutant Trading Framework	Stakeholder Task Force	Mar 2012
4	Define Credit and Develop Operating Principles	Stakeholder Task Force	Jun 2012
5	Create and Adopt Program Protocols and Program Implementation	Stakeholder Task Force	Aug 2012
6	Submit Pollutant Trading Program Report to RWQCB	Stakeholder Task Force	Nov 2012

Table 1 Data is subject to change according to available data and adaptive management changes.

Thank you for your consideration. If you have any questions or concerns regarding our proposed plan, please contact me at 951-354-4221.

Respectfully submitted,

Mark Norton

Mark Norton P.E.
LE/CL TMDL Task Force Administrator